Conference Proceedings

Integrating Research into Undergraduate Education: The Value Added

Washington, D.C.
November 18-19, 2004

Co-Sponsors: The National Science Foundation and
The Woodrow Wilson National Fellowship Foundation

The Reinvention Center
AT STONY BROOK

Conference Schedule: Day One, November 18, 2004

Integrating Research into Undergraduate Education: The Value Added

Welcoming Remarks

Wendy Katkin, Director, The Reinvention Center

Research and Undergraduate Education: A Powerful Partnership

This session will establish the essential synergy between research universities' dual missions to generate and transmit knowledge, and it will demonstrate the value this synergy brings to undergraduate education.

Playfulness and Responsibility in Education and Research

Speaker: *Nancy Cantor*, Professor of Psychology and Chancellor and President, Syracuse University

Professors Who Are Scholars: Bringing the Act of Discovery to the Classroom

Speaker: *Carl Wieman*, Distinguished Professor, Department of Physics and Fellow of JILA, University of Colorado at Boulder

Moderator: *Gail Kern Paster*, Director, Folger Shakespeare Library

Breakout Sessions: Bringing Research to the Classroom

The challenges in translating research into the classroom vary by field and educational setting. These sessions will enable conference participants to investigate strategies and methods for weaving what is happening at the research level into specific educational contexts. Although the issues of integration will differ by situation, these breakout sessions will all emphasize ways to engage undergraduates in the act of discovery.

A. At the Institutional Level

These sessions will consider ways in which research and research-related experiences can transform and enhance teaching and learning in contexts that cut across departments and fields.

- **In Introductory and Foundation Courses**
  Leader: *Joseph Potenza*
- **Within Learning Communities**
  Leaders: *Greig Stewart and Rebecca Thomas*
- **Within Research Service Learning**
  Leader: *Robert Thompson*
- **Research as an Integrative Experience**
  Leader: *Lee Willard*
- **Technology and Pedagogy: Faculty Development's Piece of the Undergraduate Research Puzzle**
  Leaders: *Renata Engel, Valerie Dudley, and James Thurman*

B. Within Fields and Majors

These sessions will examine approaches to integrating research within different fields and majors.

- **Performing and Fine Arts**
  Leader: *Donald McKayle*
- **Engineering and Computer Science**
  Leader: *Joseph McCarthy*
- **Experimental and Data-Intensive Social Sciences, Related Areas within Psychology and Management**
  Leaders: *William Frawley and Elliot Hirshman*
- **Humanities and Discursive Social Sciences: A Template Approach to Undergraduate Research**
  Leaders: *Gerald Graff and Cathy Birkenstein-Graff*
- **Life Sciences and Related Areas within Psychology**
  Leader: *Sarah Elgin*
- **Physical Sciences and Mathematics**
  Leader: *Robin L. Garrell*

Incorporating Principles of Learning into Undergraduate Education

Recent advances in the "science of learning" offer universities the potential to re-shape their undergraduate education to meet the varied needs of their large and diverse student populations. The challenge is how to translate basic research findings into educational applications. This session will provide an overview of the current state of research on learning, consider how the effective application of relevant principles can improve faculty teaching and student learning, and examine challenges of application within the research university context.

Research on Learning as a Foundation for Curricular Reform and Pedagogy

Speaker: *Elizabeth Bjork*, Professor of Psychology, University of California, Los Angeles

Improving Student Learning: Moving from the Memory Laboratory to the Classroom

Speaker: *Mark McDaniel*, Professor of Psychology, Washington University in St. Louis

Disciplinary Differences in Learning and Thinking Processes and in Teaching Strategies and Styles

Speaker: *Janet Gail Donald*, Professor of Education and Counseling Psychology, McGill University

Moderator: *Ralph Kuncl*, Professor of Neurobiology and Provost, Bryn Mawr College

Conference Schedule: Day One, November 18 - continued

Integrating Research into Undergraduate Education: The Value Added

Breakout Sessions: Applying Principles of Learning in Diverse Undergraduate Educational Settings

"How can research universities apply and extend their knowledge of how people learn, think, and remember to improve learning in the university and beyond?" Conference participants will endeavor to answer this question as it applies in specific higher educational constructs. They will also probe ways in which principles of learning can be adapted to address different disciplinary learning styles and the needs of diverse populations.

A. Institutional Contexts

- **Bringing New Learning Modalities to All Disciplines**
  Leader: *Gregory Bothun*
- **Mapping Learning Principles to Knowledge Structures in the Natural and Behavioral Sciences**
  Leader: *Kenneth Kotovsky*
- **Bringing Instructional Innovations That Work in One Discipline to Other Disciplines**
  Leaders: *Patricia J. Pukkila and Martha Arnold*
- **Engaging and Retaining Targeted Populations**
  Leader: *David Ferguson*

B. Disciplinary and Interdisciplinary Contexts

- **Performing and Fine Arts**
  Leaders: *David Hertz and Giancarlo Maiorino*
- **Engineering and Computer Science**
  Leader: *Karan Watson*
- **Experimental and Data-Intensive Social Sciences, Related Areas within Psychology and Management**
  Leader: *Milton D. Hakel*
- **Humanities and Discursive Social Sciences**
  Leaders: *Lucia Gilbert, Cory Reed, Paige Schilt, and Paul Woodruff*
- **Life Sciences and Related Areas of Psychology**
  Leader: *Diane Ebert-May*
- **Physical Sciences and Mathematics**
  Leaders: *Robert Mathieu and Marilla Svinicki*
- **Interdisciplinary Programs: Integrating Different Ways of Thinking and Different Perspectives**
  Leader: *Ellen Yi-Luen Do*

Conference Schedule: Day Two, November 19, 2004

Integrating Research into Undergraduate Education: The Value Added

Providing a Quality Research-Based Undergraduate Education: Critical Challenges of the Next Five Years

This session looks to the future and contemplates major forces that are re-shaping research universities. Three distinguished leaders in higher education will examine the challenges posed by these forces and demonstrate why and how research universities are uniquely positioned to respond.

Undergraduate Education and the Core of the Research University
Speaker: *John Sexton*, Benjamin F. Butler Professor of Law and President, New York University

Capable Language: Complex Discovery and Plain Talk
Speaker: *Robert Weisbuch*, President, The Woodrow Wilson National Fellowship Foundation

Engaging the Full Range of Students on the Right Range of Topics in the Full Range of Ways
Speaker: *Howard Gardner*, John H. and Elisabeth A. Hobbs Professor of Cognition and Education, Harvard Graduate School of Education, Harvard University

Moderator: *Judith Ramaley*, Assistant Director, Education and Human Resources, National Science Foundation

Conference Schedule: Day Two, November 19 - continued

Integrating Research into Undergraduate Education: The Value Added

Breakout Sessions: Addressing the Challenges

These sessions will examine some of the most trenchant challenges research universities will face with respect to undergraduate education. They are noteworthy for the range of issues and various aspects of undergraduate education on which they impinge.

- **Community-Based Research: Taking it to the Streets**
  Leaders: *Julie Ellison and Dennis Jacobs*
- **Developing Resources and Funds to Support a Research-Based Undergraduate Education**
  Leader: *Patricia Iannuzzi*
- **Expanding Opportunities for Undergraduate Research: Engaging the Professional Schools and Developing New Financial and Human Resources**
  Leader: *Matthew Santirocco*
- **Forming Multi-Campus Partnerships**
  Leaders: *Jeffrey T. Roberts and Robin Tanke*
- **Graduate Students as Teachers and Mentors of Undergraduate Research**
  Leaders: *Laura Hess and Janet Rankin*
- **Increasing Engagement and Retention Through Research and Creative Endeavors**
  Leader: *Pedro Castillo*
- **Promoting Connections Between Two- and Four-Year Institutions**
  Leaders: *Victor Jaime and Caesar Sereseres*
- **Research and Creative Activity: Critical Components of a Sound Liberal Arts Education**
  Leader: *Sue V. Rosser*
- **Strategies for Effecting Rapid Translation of Ongoing Research in the Curriculum**
  Leaders: *Dawn Comeau and David Lynn*
- **Teaching and Learning in an Age of Technology: The Development of a Genetics Cognitive Tutor**
  Leader: *Elizabeth W. Jones*
- **The Changing Roles of the Humanities and Social Sciences**
  Leader: *Reed Dasenbrock*

Future Directions

The conference concludes with a discussion of the major themes and recommendations that emerge from the plenary and breakout sessions. The Reinvention Center will use the discussion as a basis for establishing its priorities and planning actions for the next two to three years.

Speaker: *Gerald Graff*, Professor of English and Education, University of Illinois at Chicago

Panelists: *Bernadette Gray-Little*, Professor of Psychology and Dean, College of Arts and Sciences, University of North Carolina at Chapel Hill
Judith Ramaley, Assistant Director, Education and Human Resources, National Science Foundation
William Wood, Distinguished Professor of Molecular, Cellular, and Developmental Biology, University of Colorado at Boulder

Closing Remarks: *Wendy Katkin*, Director, The Reinvention Center

Wednesday, November 17, 2004

Pre-Conference Evening Meetings

Vice Presidents/Provosts/Deans for Undergraduate Education and Other Senior Officials With Campus-wide Responsibility for Undergraduate Education
Leaders: *Ellen Woods*, Senior Associate Vice President for Undergraduate Education, Stanford University
Al Wyner, Dean, Undergraduate Studies, College of Letters and Science, University of California, Santa Barbara

Undergraduate Research Program Directors, and Faculty and Professional Staff with Responsibility for Promoting, Coordinating, and Expanding Undergraduate Research Opportunities
Leader: *Sandra R. Gregerman*, Director, Undergraduate Research Opportunity Program, University of Michigan

Humanities Initiative
Leader: *Matthew Santirocco*, Professor of Classics, Angelo J. Ranieri Director of Ancient Studies, and Dean, College of Arts and Science, New York University

Conference Proceedings

Integrating Research into Undergraduate Education: The Value Added

Welcoming and Introductory Remarks

Wendy Katkin, Director, The Reinvention Center

On behalf of the Reinvention Center Executive Board and Stony Brook President Shirley Strum Kenny who conceived of and supports the Reinvention Center, I am pleased to welcome you. This is the Center's second major conference. Established four years ago, the Reinvention Center is the only national organization to focus on undergraduate education at research universities. The catalyst for its creation was the Boyer Commission report *Reinventing Undergraduate Education: A Blueprint for America's Universities* (1998). Noting the scope and array of resources that exist at research universities and the opportunities they create for students to have a very special learning experience, the report called upon universities to re-conceive their undergraduate education so that it exploits their distinctive assets and is infused with the same investigative frame of mind that drives their research and graduate programs. The Reinvention Center's charge was to provide leadership in efforts to achieve the Commission's vision and to be an active and informed force for change. This was a daunting challenge, given research universities' size, multiple missions, culture and traditions and the heterogeneity of their students.

Happily, as the Reinvention Center embraced the challenge, we found we had many friends and supporters. They include the 250 research university faculty, administrators leaders, professional staff, and graduate students who responded to an invitation from a new, unknown entity to attend a meeting on undergraduate education and who now form a solid corps, they include the numerous officials from educational and professional societies and government agencies who have become staunch allies, and they include the 400 individuals from 101 public and private universities who attended the Reinvention Center's first conference in 2002 and are active proponents of change on their own campuses. It has been very gratifying. I would especially like to single out officials at the National Science Foundation who have contributed intellectual capital and critical moral and financial support, for this as well as our last conference and for other Center activities.

The Reinvention Center's primary approach in its brief four years has been to bring together these friends and colleagues to discuss common problems and challenges and work collectively to develop understandings and promote actions that will lead to the kind of paradigm shifts that the Boyer Commission advocated and that are now taking place on many campuses. The program for this conference, like that of our last one, reflects the considerable input of this diverse group. The conference was a discussed at all the regional meetings the Center had this past year. Many of you here suggested topics for various sessions, recommended speakers and session leaders, and stepped forward in a multitude of ways to ensure that this second conference builds upon the first one and is as successful in stimulating ideas and actions and promoting networking among individuals across institutions.
I thank you all.

This conference is the rare forum at which university presidents, faculty from virtually every discipline, graduate students who represent the next generation of teachers and scholars, and professional staff responsible for implementing undergraduate programs enter into a sustained discussion of undergraduate education within the research university context. Today we have gathered here 400 colleagues from 116 public and private universities from 37 states, Washington DC, Canada, England and Hong Kong. The participation of this diverse group, whose members range from a Nobel winner in Physics to one of the of the world's leading choreographers, attests to the richness and variety that exists at research universities and that is beginning to have impact on their undergraduate education. It also reflects their enormous commitment. That they are joined in their deliberations by colleagues from seven professional and educational organizations, three private foundations and three government agencies that create policy and fund higher education further confirms the importance of what we are doing and the commitment of these organizations as well.

In welcoming participants to the Reinvention Center's first conference, I observed that for most of us working at a research university, the connections between research and graduate education are self-evident. The difficulty is in understanding where undergraduate education fits in. How can faculty conceive of their own research as an educational asset that can be used to both enrich course content and enhance students' disciplinary knowledge and broad intellectual growth? Whether we come from public or private institutions, small or large, we are all grappling with the same questions.

The last conference demonstrated the considerable progress research universities have made in recent years in focusing attention on undergraduate education and in emphasizing research, scholarship, and artistic creation as critical components, embedded in the curriculum as well as an independent activity. At the same time, at virtually every conference session it was noted that change has for the most part been piecemeal, and it has only partially penetrated the university culture. While the reasons for this failure are complex, there was agreement that genuine transformation will not occur until research universities collectively define, demonstrate, and communicate –to students, faculty and the general public—the distinctive value of an undergraduate education that has research at its core.

—which brings me to this conference. Our challenge in the next two days is to distill the distinct characteristics of the educational experience research universities can offer and to articulate the "value added" of such an experience to undergraduates so that it is readily comprehended. In pursuing this interest, I urge you to keep in mind NYU President John Sexton's "ideal of the research university" as the "engine" for "both knowledge creation and knowledge transmission." (The Role of Faculty, p.9)

Together, we will probe several questions that are fundamental to the discussion:

- Based on their singular assets, what is the unique educational experience research universities can offer?
- How can universities integrate their dual missions of "knowledge creation" and "knowledge transmission" in order to enrich and give new meaning to their undergraduate programs?
- How can research universities "triangulate" the faculty's own research, research advances in the science of learning, and classroom learning in order to provide a quality research-based undergraduate education?
- If active involvement in research is viewed as an important component of the undergraduate experience, what needs to happen in the classroom to enable students to participate in a meaningful way? How can they gain understanding of the discourse of their discipline, along with the specific knowledge and broad cognitive skills they will need?
- How can research universities communicate the value of a research-infused education to their diverse constituencies?

We have ambitious goals:

- Collectively, to develop an understanding of research universities' core mission with respect to undergraduate education and of the educational experience they can provide.

- To assist universities in bringing their research activities to their undergraduate education in ways that impact significant numbers of students, including members of different targeted groups and students in all majors.
- To make faculty, graduate students and professional staff with responsibility for aspects of undergraduate education aware of the substantial literature on learning that now exists and its potential applications in order to strengthen connections between research on learning and instruction.
- To provoke widespread discussion and action to address the changing state of knowledge and the changing demography of the undergraduate population and the implications both changes have for future undergraduate education at research universities.
- To lay a foundation for systematic examination of some of the most complex challenges universities will face within the next five years in designing and implementing their undergraduate offerings.

The conference is organized around three plenary sessions, each of will probe an aspect of the overall theme. These sessions will be followed by meetings in which small groups will examine issues raised by the speakers from institutional and disciplinary perspectives. In the course of doing so, participants will report on successful approaches and innovations and consider strategies for addressing the most penetrating challenges and they will gain knowledge that they can bring both to their own teaching situation and to their universities. We ask that each breakout group produce 2-3 specific recommendations for further deliberation and action by the Reinvention Center and its constituents.

Plenary Session: Research and Undergraduate Education: A Powerful Partnership

Playfulness and Responsibility in Education and Research

Speaker: Nancy Cantor, Chancellor and President, Syracuse University

I'd like to begin today by sharing with you some on-the-ground views of undergraduate research. I'll begin with a moment in Africa that changed a student's way of seeing the world. Isla Casteneda, a Syracuse undergraduate who grew up in a family of migrant workers in the South, was one of fifteen American students and fifteen African students chosen to do research on an East African rift lake. During a three-day train ride to get to their field camp, she looked out the window and said, "Look—zebras! You don't see that every day." Her African colleagues smiled and said, "Well—actually—you do." Isla said the trip to Africa changed her life and helped her decide she wanted to become a research scientist working on global change.

Jeremy Gilbert, professor of biomedical and chemical engineering, a Syracuse department that requires all seniors to do a senior thesis, often finds that undergraduates will come to him and say "this is just not working" if they have followed a strict research protocol and get unexpected results. That's when he may remind them of Rob Gettens, a graduate student of his who, not long ago, was using an atomic force microscope to look at proteins attached to biomolecular surfaces. "Every time I do it," Gettens complained to Professor Gilbert, "a funny thing starts growing, like a contaminant." The "funny thing" however, was not a contaminant. Gettens had discovered that water can become solid at room temperature on mica. Professor Gilbert will say, "What he thought was a contamination and a failure turned out to be an exciting development."

Another view of discoveries that may come to light in research can be found in the undergraduate thesis, "An American Modernity," written for our Renee Crown Honors program last year by Assad Rajani. Rajani, who came from East Meadow, New York, graduated with majors in English and textual studies, history, religion, and political science. As that list alone indicates, his interests crossed the lines of many disciplines.

"As a Muslim-American student, a project that focuses on the fissures of ethnic identity is extremely relevant to me," he explains. "Especially in the post 9/11 era, it was important to elucidate the experiences of minority groups that are often considered outsiders to mainstream American culture."

In modernity, he writes, "I am describing something that changes as I struggle to study it. Like students of the subconscious, the galaxy or the atom, I can only relate modernity's significance through language—that is through analogy. I cannot tell you what modernity is, only what modernity is like."

Not that he didn't try. One of Rajani's first questions to his faculty advisor, Professor Gregg Lambert, was: When was modernity? Or when did it start? He continues: "I wanted modernity to be located on a one-dimensional timeline." His professor "just smiled. I thought he evaded my question; I still do, actually. Gregg knew that my request was a form of control, a way for me to fold up modernity into a nice symmetrical package for me to get. The truth—or at least what I believe the truth to be—is that several modernities have existed." Rajani goes on to explain that his undergraduate thesis is "an American modernity, not the American modernity."

Rajani's thesis discusses insights from writers ranging from Sigmund Freud to the Native American author Sherman Alexie, from the Buddhist monk Buddhagosa to W.E. B. DuBois, who asked "Why did God make me an outcast and a stranger in my own house?" But some of the most poignant insights into his situation come when he interrogates his own experience with toilet paper.

"Bathroom etiquette was never a mystery for me," he writes. "My mother was quite candid about it. She used to tell me not to use American bathrooms. All these people just use paper! Hold it in until you get home. Home was transformed into a cultural fortress." Home, he adds, was the only place the topic ever seemed to come up. It was not until he was a sophomore at Syracuse, heading toward the floor bathroom with his jug of water, that his roommate had the courage to ask him outright:

"What's with the jug? Where are you going?"
"To the bathroom."
"What's that? What for"?
"To clean myself, man. I don't just use paper."
"You're kidding me, right?"
"No, I'm not."
"Whoa, whoa, whoa. You mean you use your…your hand??"
"I need to go."

"The reaction was worse than I ever expected it to be," Rajani writes, explaining that water is a central symbol of spiritual and hygienic purity in Islam. 'For 19 years I had hidden this secret, and now not only was I being confronted with an image of my own body in such a brusque manner, I was being ridiculed by someone who perceived me to be unhygienic…My act of hygiene, my act of purification and bodily cleansing was considered unclean."

The confrontation, he reports, ended in uneasy laughter, without answers.

As the Boyer Commission first recommended in 1998, research introduces undergraduates—sometimes in dramatic ways--to the processes of inquiry that are involved in the production of new knowledge. And although the Commission reported three years later that the humanities and social sciences were lagging behind the laboratory sciences and engineering in hands-on research, we are now seeing compelling examples of how undergraduate research adds value to education in all fields.

What value does it add? There are, of course, many answers, some general and others quite specific, to this question, and I want to begin with a rather general framework about liberal education today. As we all have experienced, education can be transformational, especially when it simultaneously cultivates an attitude of playfulness (about ideas and truths and experiences) and of responsibility (to ground that playfulness in the world as it now seems and/or could become). In its most general sense, I believe that the value-added of a research experience is that it sharpens the educational process and turns it toward the kinds of creativity grounded in experience that is transformational. There are many such opportunities in college, but engaging in undergraduate research is more likely than not to lead in this direction.

The research/discovery process is one that provides a context of creativity, much akin, in my view, to the sharpness and intensity of artistic exchanges. Barbara White, a composer at Princeton, recently described the creative campus as one that encourages "experience-oriented imaginative space." That is what we are trying to do when we engage students directly in the discovery process. That is what happens when Professor Gilbert's students learn that what appears to be a failure may actually be a discovery. That is what happens when a student such as Isla Casteneda is plucked from her own familiar habitat and surprised into seeing the world from another's view. And that is the effect of Professor Lambert's refusal to place definite boundaries on modernity, inducing Rajani to explore between worlds, locating the sometimes painful distance between his own and others. These experiences all occur in that "experience-oriented imaginative space" likely to engage our students in being both playful and responsible with ideas.

Cultivating the Creative Campus

If an important aspect of the value added by undergraduate research is that it embeds the student in the heart of the creative campus – a place where people and ideas mix both playfully and responsibly – how can we maximize that value? And where do we see it happening?

We think about our laboratories, of course, but we can also include more of our campuses and the wider community, as near as downtown, as far away as Africa, and anywhere in between, thanks to the internet and the technology that allows us to build networks in which we can collaborate and share knowledge. Just as we want to encourage creativity and innovation, we need to be very opportunistic and expansive about embedding research experiences directly into the "work" of our faculty and colleagues. Undergraduate research experiences can and should be found in a variety of settings and programs – from libraries and museums to homeless shelters and research vessels. The magic, in some sense, of a research university setting is that it is literally full of such opportunities if we can only harness them as such! And the experiences do not have to conform to the academic year, but rather can take advantage of faculty's propensity for doing major fieldwork in the summer. For example, at Syracuse, for two summers, the Earth Sciences Department Seismic Analysis Laboratory included undergraduates in its research cruises on Skaneateles Lake, one of the eastern Finger Lakes of Central New York.

These kinds of "off-shore" experiences speak directly to the central discovery mission of our universities and to our ability to prepare students for the world of innovation beyond the academy. For, as often as our students think of research as preparation only for graduate school, the reality is that this kind of experience will be preparation for life and for work in any number of sectors in this "knowledge economy."

Consideration of this aspect of our educational mission raises another question. What opportunities will these students find after graduation, and how can our undergraduate research experiences best simulate the creative process at the heart of our ever-changing global knowledge economy?

For the past six months, IBM has been brainstorming precisely this question, internally and with participants from many sectors around the world, in something they call a Global Innovation Outlook, an effort to understand the nature and practice of innovation, which they define as the intersection between invention and insight, when a new thought, technology, business model or service actually effects change in society. Innovation, in this way of thinking, requires human interaction and broad-scale adoption, and "is always more about what we do with an idea than the idea itself."

Innovation, as they have found, is occurring more rapidly as barriers of geography and access come down. It requires wider collaboration across disciplines and specialties. It often involves human communication across generations and across cultures. To do this in the future, our students must begin now to learn to think quickly, to simulate possibilities, to test ideas, and to work in groups. They must learn to work with diverse others in interdisciplinary settings, on campus and at the interfaces of business, academia, and the wider community. They have to develop a tolerance for sharing and investing ideas in work groups that are less stable and hierarchical and more "horizontal" than ever before, with fewer experts and bosses and more colleagues and generalists. They have to care less about ownership over and credit for ideas and look instead for opportunities to pool knowledge and test ideas collectively. They also have to be comfortable in a world in which "learning" and "working" never stop, 24x7.

The dynamics of this global knowledge economy are double-edged, in my view, for research universities. On the positive side, if there is any sector in higher education that should be able to engage students in this kind of intensive, multi-disciplinary, collaborative learning experience, including partners from industry, government and community organizations, and reaching outside our country, it is our universities. Yet, we also know that our institutions are all struggling themselves with how to break down the almost feudal hold of departments and the rigidity of our tenure and promotion systems, not to mention our reluctance to share intellectual property or give due credit to collaborative work. Nonetheless, as we are all working on exactly these issues, we should all ensure a role for undergraduates right in the midst of the next generation of "work groups" in our institutions.

At my institution, for example, we are deeply involved in a new Center of Excellence on Environmental Systems and Energy that includes collaborations across 12 academic institutions in Central New York and numerous business partners and a test-bed facility to share discovery work in downtown Syracuse. As we work out the intricacies of multi-site experiments, translations from discovery to marketplace, and collaborations with community partners to apply these new technologies to improve human health and sustain our urban environment, it is

critical that we not forget to include our students, undergraduates as well as graduate students. While we might be tempted to postpone that part of the project until all else is running smoothly, we do not want to risk missing an opportunity to introduce students directly to the world into which they will graduate, a world that includes uncertainty, mistakes, and new starts. It is imperative that we stretch the boundaries of the creative campus right from the start.

Building Cultures of Innovation

Now, how realistic is this? Mary McCarthy once wrote: "If someone tells you he is going to make a "realistic decision," you immediately understand that he has resolved to do something bad." When we think about change, when we think about excellence, we have to be realistic—but in our case, that means we should plan to take advantage of what we have and to create new ways to use it. In the present context, I believe that we can use undergraduate research as a catalyst for institutional change, as well as for the transformation of undergraduates into creative thinkers.

In support of this effort, I thought I would list some of the assets that could be added to our campuses as we engage more thoroughly with undergraduates in research.

Cultures of collaboration. First, I suspect that as we work with students on research, we will be forced to consider how well we really do at collaborative work. Interestingly, our students may well be better at collaborative work than we are – after all, many of them have grown up playing on teams or performing in theater groups; they have even had chat room experience; and their schooling is likely to have included a bit more of this joint work than ours did. Although they, too, will have to work at collaboration--especially in diverse work groups--they still may have much to teach us along the way.

And we all have much to learn. Even our science and engineering faculties, those most likely to run collaborative laboratory groups, upon close examination often admit to adhering to rather rigid hierarchical structures without real sharing of ideas and pooling of knowledge and credit. Certainly our humanists, who count as collaborative research the prototypical faculty-student honors thesis (even as good as those experiences can be), can learn a great deal from their students about sharing knowledge in the process of innovation. By contrast, our performing arts faculty, who seem to create together, have a great deal of trouble assigning credit to this collaborative work. So there is much room for self-examination, and I believe that integrating collaborative undergraduate research into the heart of our most exciting scholarly projects might be a good catalyst for change.

Cultures of diversity. And speaking of institutional change, we certainly all want to encourage intellectual and social diversity as a core part of our community, not as some add-on on the margins. Again, I think that research experiences are fertile ground for this cultivation of diversity and excellence, hand in hand.

Moreover, this is work that takes energy and commitment. As we engage with our students in new ways, across generations and in new settings, we may well come to see how hard it is to get in the heads of those with different backgrounds from our own. Recall, for a moment, the interaction over toilet paper reported in Rajani's thesis on modernity or Isla's insights on zebras in East Africa. These "research opportunities" can illuminate far more than the topic at hand. Just as the students stretch with that experience, so can we as faculty and as institutions.

Cultures of risk-taking and connection. In the process of stretching the creative campus, we also should be mindful of the occasional need to encourage some risk-taking on the part of our faculty. If we want to be seen as engaged institutions, contributing to the social and economic health of our communities broadly defined, we must modify our views of what faculty members (and their students) should do with their time. We should structure ourselves in ways that create vibrant exchanges of people and ideas. We want to create startling combinations with respect to who we are and bump minds with, and how we work within and across disciplines, technologies and methodologies. And, again, our students' interests in being engaged with the world can serve as good incentives for us in taking some risks to move beyond our campuses, libraries and laboratories.

That said, community-based research projects are extremely difficult to do well. They require building trust, ensuring reciprocal benefits to community as well as to campus, and maintaining partnerships over time. In this respect, all hands are needed, and the intergenerational, collaborative research model can be very useful. However, as with any large project, the same undergraduates who bring energy and a fresh look at the issues also require and deserve intense supervision. When collaborative projects are done right, everyone wins.

A recent project in Syracuse, for example, drew on the talents of faculty, graduates, and undergraduates to map hunger in our city under the guidance of the Samaritan Center, which had tried for some time without success to describe the changing needs for emergency food services and the resources available to fight hunger in the city. As Syracuse Professor Don Mitchell, chair of Department of Geography in the Maxwell School of Citizenship and Public Affairs observed, the governmental social services offices and human service agencies and programs were fragmented and trying to deal with "a vastly uneven landscape where deep food insecurity can exist cheek by jowl with abundant wealth and comfort." The hope at the beginning of this research project, in the fall of 2003, was that all the entities involved in the local fight against hunger could learn much more by collecting and sharing information in a single local database. Dale Johnson, executive director of the Samaritan Center, hoped that the geography department could add technological sophistication and professional expertise in presenting and analyzing the information that was collected.

This extraordinarily labor-intensive and complex project has galvanized a great deal of Syracuse, and students have been at its heart from the beginning. Students in Professor Jane Read's undergraduate geographic information systems class in the Maxwell School used the latest Geographic Information System software to construct overlays incorporating information from more than a dozen social service agencies in the city, as well as from ten city, county and state agencies. Other students, from Syracuse and also from neighboring institutions (LeMoyne College and UpState Medical), worked with faculty mentors to scour the city, doing surveys of the availability of food in local pantries and of the shopping patterns of low income residents. In other words, the project mixed methods and contexts of data collection, and our students got a first-hand immersion in the alarming world of urban poverty and hunger. The project also represented a

learning community that was thoroughly intergenerational, with graduate and professional school students' serving as the glue, translating between worlds in their dual roles as "experts" for the undergraduates and "novices" for the community partners.

As we all pursue a more community-engaged research agenda, we should not miss the opportunity to engage our undergraduates, as they will someday lead these communities. By stretching the boundaries of our own creative campuses, we will go some distance toward fulfilling our mandate to educate citizens ready to make a difference in the world. Student contributions to these efforts have been and can be substantial making it feasible to collaborate on a relatively large scale, and, in the best of cases, build considerable public trust in the next generation of college-educated citizens. Listen to the words of the Syracuse community activist, Dale Johnson, Executive Director of the Samaritan Center, in his April 23, 2004 executive report:

"One final note----a significant part of the work of the Syracuse Hunger Project was performed by students. The contributions of these students deserve this community's gratitude."

This reaction comes in the context of a very challenged community that is generally quite suspicious of the "folks on the hill."

Benefits and Hard Work for All

Throughout my comments today, I have emphasized the reciprocal benefits—for faculty, students, and our institutions—of engaging undergraduates at the center of our creative campuses. Admittedly, this is not an easy undertaking at research universities, especially as resources shrink and the juggling act of our faculty members intensifies. Undergraduate research is time-consuming and resource-intensive, and many faculty members do not feel adequately rewarded or compensated for this kind of work. There are also some specialties that would find it very difficult to include undergraduates who know nothing at all about a scientific field or nothing at all about talking with people who are not just like them. But there are faculty members who have told me that they find undergraduate research to be intensely rewarding, even in fields in which undergraduates might seem difficult to incorporate.

To end on a positive note, I'd like to quote Professor Gilbert again, because I think his observations about the serendipitous nature of research apply across the board.

"I try to get students to understand that, as scientists, we design experiments and hope for an outcome, but we expect the unexpected. And I tell them, 'When you find something you don't understand, explore it—don't write it off. If we always knew that when we do A, B, and C, we'll get D, I'd look for something else to do. But if E, F, and G show up, that's wonderful. That's what gets me excited about science."

Let's keep looking for ways to share the lessons, the adventures, and the excitement of research and discovery with our undergraduates.

Resources/References

Websites

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2. Syracuse University's Freshman Honors Seminar is an ongoing orientation to the University that introduces students to the world of ideas and the many educational opportunities available on campus and in the community at large. http://thecollege.syr.edu/depts/honors/courses/OrientationSeminar.htm
3. To learn more about Syracuse University's Department of Earth Sciences Seismic Analysis Laboratory visit http://earth-sciences.syr.edu/
4. IBM convened the Global Innovation Outlook where more than 100 leaders from business, academia, government, and other organizations joined with IBM's top researchers and consultants to examine the future of healthcare; the relationship between government and its citizens; and the intersection of work and life. http://www-306.ibm.com/e-business/ondemand/us/innovation/gio.shtml
5. Syracuse University's Center for Excellence on Environmental Systems and Energy is a collaboration of universities, researchers, corporations, and economic development groups that work to develop new technologies, solutions, and applications to improve human health and productivity in built and urban environments. http://coees.syr.edu/
6. The University of Illinois' Learning in Community (Linc) program is a campus-wide course open to all undergraduates, that prepares students for civic engagement through community-driven projects. http://www.linc.uiuc.edu/index.html
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8. Syracuse University's Department of Geography Professor Don Mitchell is founder of the People's Geography Project, designed to popularize and make even more relevant and useful to ordinary people the important, critical ways of understanding the complex geographies of everyday life that geographers have and continue to develop. http://www.peoplesgeography.org
9. Syracuse University's Department of Geography Professor Jane Read's Geographic Information Systems course: http://classes.maxwell.syr.edu/geo383-683/
10. Syracuse University's Research Experience for Undergraduates Program is a summer program in which students formulate their own research project with the help of a mentor. http://www.-che.syr.edu/REU/index.html
11. The National Science Foundation funds research opportunities for undergraduates through its REU Sites program. http://www.nsf.gov/home/crssprgm/reu/start.htm

Partnerships of Research and Undergraduate Education

Speaker: Carl Wieman, Distinguished Professor, Department of Physics and Fellow of JILA, University of Colorado at Boulder

This talk on the partnership of research and undergraduate education was organized around five main points:

- Essence of meaningful education
- Essential role of "experts"
- How well are we doing at achieving meaningful education?
- Relevant research on how people think and learn
- Combining experts in the subject with research on how people learn: A better approach

Essence of a Meaningful Education

A meaningful science education involves transforming the way in which students think by promoting a progression from "novice" to "expert" in both their attitudes and their approaches to the discipline and problem

solving in that discipline. Today's educator should aim not simply to produce more scientists, but rather to get all students to learn to think about science like a scientist. Similarly, the goal of education in general is to get students to think like experts more broadly Research has shown that expert competence is characterized by two things: A body of knowledge or facts, and an organizational structure that leads to effective retrieval and application of those facts. Compare a mass of papers piled randomly on a desk with those carefully organized in a file cabinet with the information in a students brain. One organization is far more useful than the other. Too often, teachers worry only about transferring more facts, rather than helping the students develop a suitable organizational and retrieval system. To do the latter, they must actively construct a new way of thinking. Effective teaching is compelling students to think and helping to guide their thinking so that they learn to think like experts. Studies have shown that this mental construction process must build on the existing foundation of student experiences and thinking.

Figure One

Essential Role of Experts

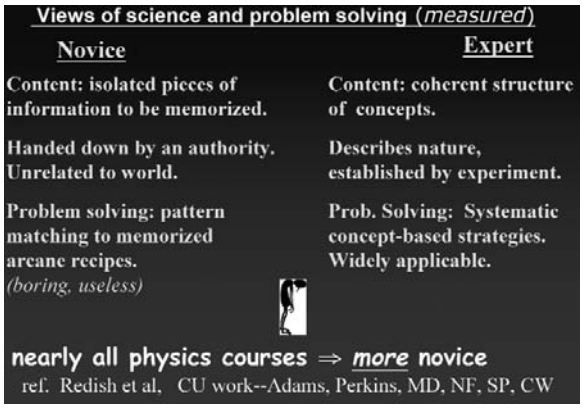
If students are to be guided to think like experts, it is clear that experts must provide that guidance. Expertise in the subject is thus essential to provide a deep understanding and education in any subject. This opportunity to have experts guiding students to become more expert-like in their thinking is uniquely provided by the research university. However, is it enough? Below I will examine data that looks at some measures of how "expert-like" students have become in their thinking after completing introductory physics courses.

Data on the success of traditional lecture approach to science teaching

Data obtained from introductory physics classes provides information on the shortcomings of current teaching approaches, such as the traditional lecture and homework assignments, in promoting meaningful education. First I consider views about science and scientific problem solving. Research has shown that people's views lie on a spectrum with the novice's views of science and problem solving at one end and those of the expert at the other. For the novice, science consists of memorizing isolated pieces of information, handed down by an authority, that is unrelated to the world outside the classroom. Within this context, problem solving is a boring and useless exercise involving matching patterns to memorized arcane recipes. In contrast, experts see science as a coherent structure of concepts described by nature and established by experiments, and they are engaged in systematic problem-solving concept-based strategies, with wider applicability to the world.

The research of ourselves and others has shown that nearly all introductory physics courses, and particularly traditional courses, cause students to shift to be more novice-like! This is exactly the opposite of our educational goal!

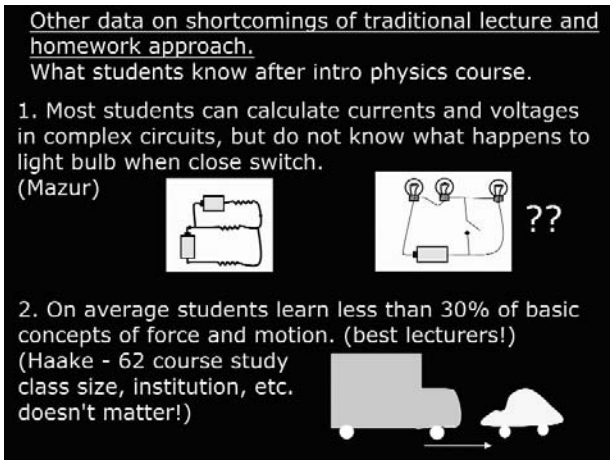
Figure Two



Next, let us look at conceptual understanding—a key element of an expert. Mazur (1997) found that after completing his course on electricity most students are able to calculate currents and voltages in complex circuits, but they do not know what happens to a light bulb in the circuit shown in figure 3 when the switch is closed. This experience has been repeated by many other teachers at other institutions. Thus students are successful in the course by memorizing problem solving recipes, but they do not understand basic underlying principles.

Another study, conducted by Hake (1998), looked at students' understanding of basic concepts about force and motion that were the core of the introductory physics course on mechanics that they had just completed. His study involved 62 physics courses at a range of institutions. Hake found that on average students who complete a traditional lecture course learn less than 30% of the basic concepts of force and motion that they did not know at the start of the course. Neither the type of institution they attended nor class size mattered significantly. Though students are passing courses, they are not learning to think like experts. To the contrary, these and other studies suggest that nearly all physics courses produce students who at the end of the semester are more novice in their mode of thinking than when they started the course.

Figure Three



These findings lead to several conclusions:

- Science faculty are poor at knowing what students are—and are not—learning. This does not mean that they do not care; rather, it suggests that they do not realize that what they are doing is not working.
- For most students "learning" consists of rote memorization of facts and problem-solving recipes. This kind of learning is short-term and useful mainly for passing class examinations.
- Most students do not gain a meaningful understanding that allows (scientific) concepts and problem solving to be usefully applied in new situations.
- Faculty may want students to learn, but they are often misled by tradition and by what worked for them when they were students.
- Expertise in a subject is not enough to foster meaningful education.

Combining experts and research on how people learn: A better approach

Relevant research on how people think and learn

Effective teaching involves helping students construct a new way of thinking-guiding them towards thinking like experts. While expertise in a subject is essential and, as the evidence shows, can be uniquely provided in a research university classroom, subject expertise alone cannot lead to meaningful education. What is missing? How can we improve on what we're doing?

To improve their own teaching and student learning, educators should eschew tradition and turn to the tools used every day in science research. These are: 1) Practices and principles based on research and on real data on how people learn; 2) more effective uses of technology; and 3) disseminating and building upon successful approaches. There is a significant body of research on how people learn that we can draw upon to guide our teaching. Our teaching would improve if we modeled it on what we do in research. As we do in our research, we should find out what works and copy it, rather than reinventing everything each time we teach, as is so often done!

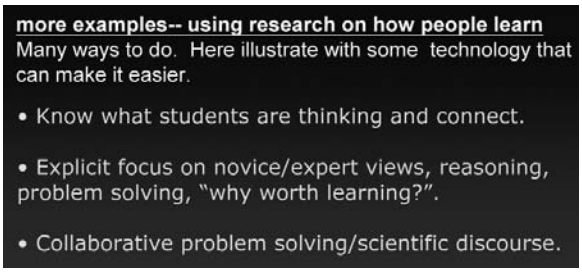
Let me now offer some rather basic but very useful results on how people learn that has come out of research on cognition. The first is the idea of "cognitive overload," which can be compared to a computer with too many windows open. The more ideas a person has to process, the less effectively they can mentally process anything. So if they are given one item to deal with, they can do so quickly and effectively. If burdened down with several at the same time, they struggle and slow down greatly. And if a great many new ideas are dumped on them all at once, they are mentally "squashed flat" and are able to absorb almost nothing. The research has shown that people are roughly speaking able to deal with a maximum of 7+2 items in their short term working memory.

When teaching, we need to keep these limits on cognitive processing firmly in mind and choose the information that we present to them carefully. Is that new technical term really 1/7th of what you want the students to learn from the day's class? By reducing jargon, limiting the number of topics, and using familiar analogies and interactive simulations, we can minimize cognitive overload and help students to think better.

This works at every level. I have seen how my physics research on Bose-Einstein Condensation can be successfully presented to both Physics Department colleagues and a class of non-scientists in a very similar way by following these pedagogical principles and using interactive computer technology.

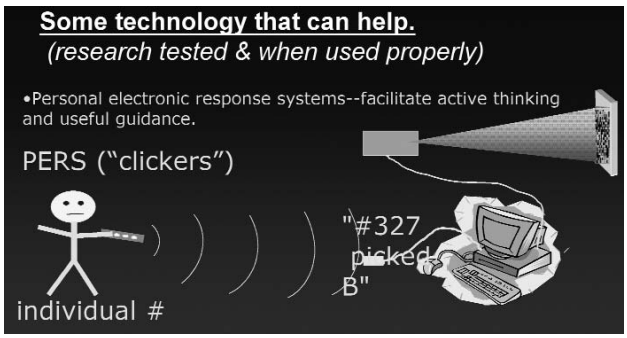
Collaborative problem solving represents another particularly effective approach to learning because it facilitates an explicit focus on the different modes of thinking novices and experts bring to an endeavor and on the meaningful contributions that experts can make, based on their subject expertise and understanding and experiences.

Figure Four



Technology, when research tested and used properly, can be incorporated effectively into the classroom and homework to enhance teaching and student learning. An excellent example is the Personal Electronic Response System (PERS), which has been used in introductory physics courses to facilitate communication between students and the instructor and give both immediate feedback on the students' understanding of concepts presented in class. In classes that use PERS, every student is issued a clicker which is assigned a number specific to that individual. When questions are asked, students in groups of three discuss the answer and use buttons corresponding to multiple choice answers (a, b, c, d) to enter their answer. The data is available during class, providing instant feedback on how individual students answered the question and how they answered relative to the rest of the class. Classes can be built around a series of questions, challenging concepts or applications, or predictions in experiments. Clickers allow the instructor to connect with what students are thinking, monitor which concepts they understand and gauge the effectiveness of his or her teaching. For students, this mode of teaching fosters an intellectually active dialogue and an appreciation for collaborative problem solving and scientific discourse (or discourse in any subject). Experience has shown that clickers can radically transform the classroom and guide student thinking. The PERS clicker provides a powerful psychological combination of personal accountability, commitment and peer anonymity. Knowing that the professor has the ability to view all of the responses from the student by consulting the information stored in the computer causes the students to feel accountable and take the questions seriously. The anonymity of the clicker allows students to be honest in their answers, rather than be distracted by worrying about how other students will react to their answer. These features make the PERS much more effective than most other forms of classroom feedback from students.

Figure Five



The use of PERS can be readily demonstrated through the example of an introductory physics class in which students were asked to use their clickers to answer the question, "What produces sound in a violin?" They were given four possible responses: A string, sound post, back board/wood of the violin, or none of these. Roughly 10% chose the right response—even after they had been told the answer only ten minutes earlier—providing clear evidence of what is actually being learned (or not learned) in the classroom, Figures Six through Nine show how instructors can use PERS to build the class around a series of questions that challenge concept and applications.

Figure Six

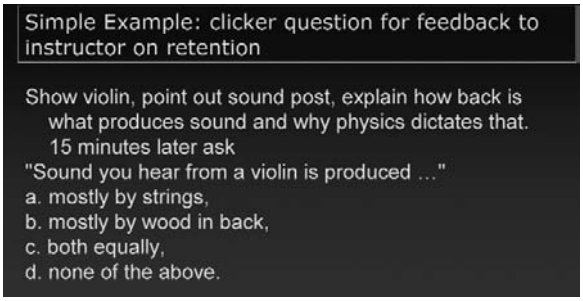


Figure Seven: Class Response

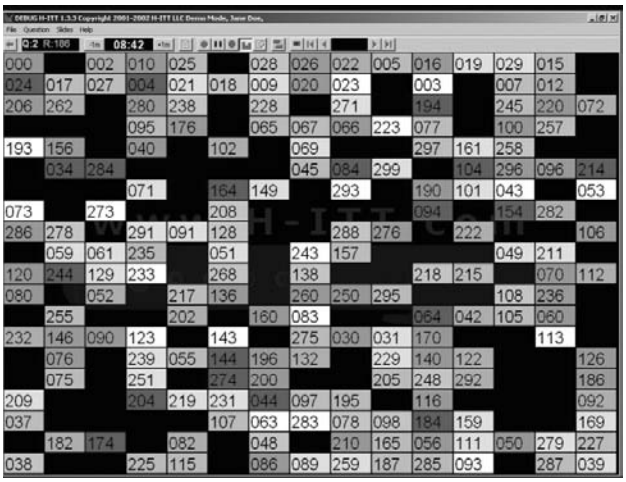


Figure Eight

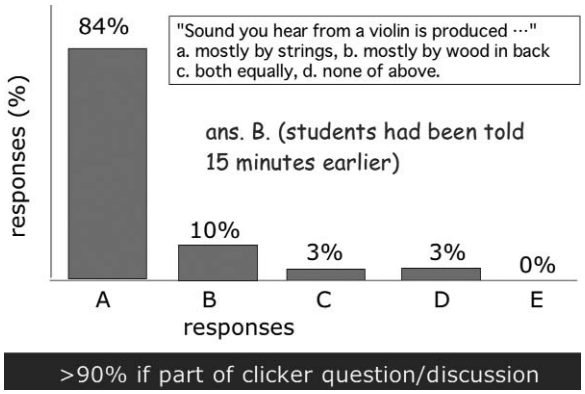
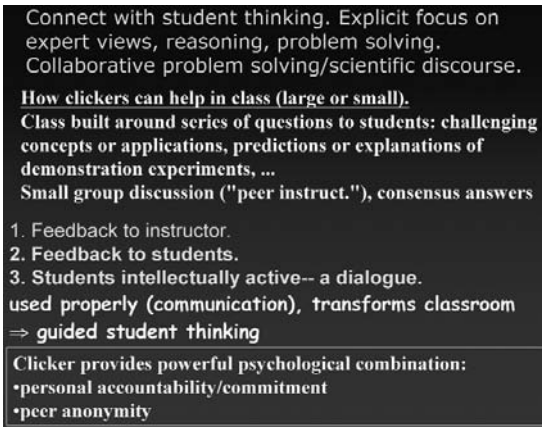


Figure Nine



In my own introductory physics classes, I assign seats so that students are part of a fixed group that must discuss questions and come to a consensus answer. This not only provides the feedback of the students' PERS answers, but by listening in on the student discussions, I can gain a much better understanding of exactly what ideas the students do and do not understand, and can target the subsequent discussion accordingly. Thus the value of PERS technology is not only in its capacity to test for acquisition and understanding of information, but in its serving as a power tool for facilitating communication between the students and the instructor.

In summary, the research university has the potential to play a uniquely valuable role in improving education, but to realize its potential it will need a combination of the subject expertise of active research faculty and research in applications on the science of learning and the application of tools of research.

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POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Weiman/Powerpoint.pdf

Breakout Session: Bringing Research to the Classroom Within Introductory and Foundation Courses

Leader: Joseph Potenza, Professor of Chemistry, Rutgers University
Recorder: Natalie Phillips, Graduate Student, Department of English, Georgetown University

Presentation

The Boyer Commission report enumerated ten ways to change undergraduate education at research universities. The session focused on two of the recommendations which are particularly relevant to the design and teaching of introductory and foundation courses:
To "make research-based learning the standard," and to "construct an inquiry-based freshman year."

Rutgers University's Chemistry Department offers several undergraduate courses and research opportunities that were created with these two Boyer Commission recommendations in mind. One is an introductory course for non-science students, "Impact of Chemistry," that may be used to satisfy a science requirement. Students in the class range from freshmen to seniors. The course uses group work, case studies, and a research experiment involving field work to give students a "research" experience. Students collect and analyze samples and present their findings in a poster format at the end of the course. Similar courses which also satisfy science requirements while emphasizing group work, writing skills, and experimentation, are offered in Biology, Physics, and Mathematics.

A second course, directed at first-year students in Chemistry and related fields, is currently being developed jointly by the new Rutgers' Undergraduate Research Center, a local community college, and a county college. The new course, "Introduction to Research," will be offered in the second semester and taken by fourteen Undergraduate Research Center Fellows selected from the approximately 100 students who participate in an inquiry-based learning experience in a General Chemistry laboratory course during their first semester. In the "Introduction to Research" course, the Fellows will be paired with both faculty and graduate students who will serve as "near-peer" mentors. They will work with the graduate students in the laboratory and be considered full members of their research groups. The "Introduction to Research" course will feature discussions of chemistry as a discipline and its role in the biomedical sciences, pharmacy, environmental sciences, and industry. Students will make site visits to local industrial or pharmaceutical firms where both fundamental and translational research is being performed. Some of the firms, which include Enzon Pharmaceuticals, Johnson & Johnson, Merck, Novartis, Schering-Plough and Wyeth, may be asked to serve as corporate sponsors for the course. Students will also have the opportunity to speak with graduate students within their department about the pros and cons of continuing in academia. At the end of the semester students will give oral presentations on their research.

In addition to these and other similar courses, Rutgers has an Undergraduate Research Fellows Program that is open to students in all disciplines. Students selected as Fellows receive a stipend to facilitate their conduct of a research project. Fellows typically produce a thesis or article that may be published in the Rutgers Scholar, an in-house e-journal.

Discussion

Professor Potenza posed several questions to the group, which was made up equally of natural scientists, social scientists and humanists:

- How can the thrill of discovery, the creation of new knowledge be introduced to beginning students?
- What should be the guiding principles of such an introduction?
- Is inquiry-based learning discipline or department specific?
- Are changes in academic culture required in order to provide inquiry-based learning to all students? Is it possible?
- If so, what would be the role of faculty, department chairs, deans, and central administrators?

The participants chose to focus on three major challenges to giving all undergraduates the kind of inquiry-based learning and research-related experiences advocated by the Boyer Commission: Scaling up effective courses and other initiatives like the "Introduction to Research" course and the Fellows program to accommodate more and a broader range of undergraduates; financial and other resource limitations; and involving larger numbers of faculty. The latter is particularly challenging in some disciplines in the humanities and lettered social sciences that do not have a tradition of undergraduate scholarship.

All agreed that it would be ideal if all freshman classes were "inquiry-based," but, logistically and financially, this is impossible. However, most believed that it would be possible at their home university for all first-year students to take a "discovery seminar" in at least one discipline. Participants whose home institutions had discovery seminars agreed that students who participated in them generally had higher retention rates and higher GPAs than those who did not. Most felt that if students could learn critical thinking skills, those skills would be transferable to other disciplines and to classes in which less personal attention was available.

Participants discussed the need for a change in the academic culture of introductory classes. Most felt that while "in-depth" or original research was impossible in introductory courses, inquiry-based courses could instill in students an understanding of the value and process of research, and could help them develop the thinking skills necessary to conduct research in the future. The participants agreed that introductory courses that emphasize research and research techniques would generate strong student interest, lead students to ask important questions, and drive them to seek further research opportunities in the future. The group discussed the importance of incorporating technology, especially simulation, into introductory laboratories. It was suggested that data bases could be used both to connect undergraduates (via keyword searches) with faculty willing to serve as mentors and to publicize research opportunities in specific fields.

Finally, the group discussed ways to overcome faculty resistance to expanding undergraduate research and/or inquiry-based learning. One factor in their resistance is the sense that they are already overloaded. It was suggested that universities offer sabbaticals conditional on a faculty member's participation in undergraduate research. Another suggestion was for universities to devise strategies to help willing faculty to maximize their interactions with undergraduates, given their limitation of time. The group agreed that identifying specific "learning outcomes" and formulating "mission statements" for each class would help instructors focus their energies on the goals most important to them. All agreed that a mentoring chain (faculty/graduate student, graduate student undergraduate students, and upper-level undergraduate student freshman) was an excellent way to transmit knowledge about research to first-time researchers.

Recommendations

- Incorporation of one's own research: Faculty should be encouraged to incorporate their own research into classroom activities, either through discussion or student participation. This would enable students to gain an appreciation of the significance of research and of the significant research being conducted at their university.
- Semester-long inquiry-based project: Rather than beginning anew each week or class period, faculty should structure their classes, especially first-year "discovery" seminars, around a semester-long inquiry-based research project that would continue throughout the semester. Suggestions for such projects include, in Biology, bacteria typing in a biology lab and, in Political Science, research gathering for a case soon to be heard at the Supreme Court. A small fraction of the time of each class or lab meeting could be devoted to these projects, allowing other, more traditional material, to be presented or discussed in parallel with the project.
- Discovery Seminars: Universities should require all first-year students to take to an inquiry-based discovery seminar that will introduce them to the kinds of critical thinking skills necessary

to conduct research and to thrive at a research university. Although the group recognized that some classes for first-year students must be taught in a formal lecture style, it would be desirable for each student to have, as a minimum, one discovery seminar in the first year. Such seminars could be offered in any or all disciplines.

- Redefining "research." Rather than focusing on developing in-depth research opportunities for the best students, faculty should focus on giving every student a taste of inquiry-based learning and "research." Rather than expecting students to conduct original research while at the university, the emphasis should be on developing in all students the critical skills and awareness of the procedures of research.
- Utilize technology more fully. Participants in the discussion recommended ways in which technology can be used to allow undergraduates to find research opportunities and funding. The University of Texas' EUREKA data base, for example, enables students to do a keyword search that generates a list of related research opportunities. Computer simulations in science labs reduce costs and give students some sense of experimentation and inquiry. Lastly, use of the Personal Electronic Response Systems (PERS) provides an opportunity for class participation and active learning, while giving the instructor instant feedback regarding the degree to which students in a given class have mastered a particular concept.

Resources/References

Websites

1. The Boyer Commission Report on Educating Undergraduates in the Research University (1998) http://naples.cc.sunysb.edu/Pres/boyer.nsf/
2. Many Rutgers University academic departments offer undergraduate research opportunities. Visit Rutgers University at http://www.rutgers.edu/
3. The Rutger's Scholar Program enables seniors to pursue original graduate-level research under the guidance of a faculty member: http://rutgerscollege.rutgers/henry.htm
4. Rutger's Integrative Graduate Education and Research Traineeship (IGERT) is a NSF-funded program that trains graduate students to become experts at the integrative synthesis and analysis of biological interfaces. http://www.igert.rutgers.edu/researchsamples.php
5. Rutgers Undergraduate Research Fellows Program supports research projects involving both faculty and undergraduate student's participation: http://web.rutgers.edu/urru/forms/grants00.htm#RURFdesc

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Potenza/Powerpoint.pdf

Breakout Session: Bringing Research to the Classroom within Learning Communities

Leaders: Greig Stewart, Executive Director of College Park Scholars, and Rebecca Thomas, Assistant Director of the Gemstone Program, University of Maryland
Recorder: Patty Alvarez, Doctoral Student, College Student Personnel, University of Maryland

Presentation

Learning communities afford universities a unique opportunity to engage students in active learning through a variety of experiences both inside and outside of the classroom. The session leaders opened their presentation by distinguishing briefly between two types of learning communities—those that have a living component and those that do not—and by describing the two communities with which they work: the College Park Scholars and the Gemstone Programs. Questions and discussion were interspersed with the presentation since many of the attendees sought details that might inform their work with newly developed programs or already existing programs.

College Park Scholars http://www.scholars.umd.edu/
This is a multi-disciplinary two-year living-learning program for academically talented freshmen and sophomores. It was founded ten years ago as a special program for students who were not being served by the University's Honors program. When Scholars began, it had four interdisciplinary thematic programs: Arts, International Studies, Life Sciences, and Science, Technology and Society. The Scholars community now has twelve diverse programs that focus on a specific theme and offer specially designed courses and experiences that relate to its theme. The programs are funded by the Provost and the home college of a particular program.

Curriculum
The curriculum consists of program specific courses and supporting classes, totaling 12-15 credits. Most of the courses may be used to fulfill university CORE (general education) requirements or major requirements. The curriculum is designed to allow students to develop an interdisciplinary concentration that can complement their major, help them explore potential majors, or serve as an additional area of academic focus outside of their major. Upon successful completion of the program, scholars receive a citation on their transcript.

Three key aspects of the program are the Colloquium, the Discovery Project, and the Capstone experience.

- Scholars enroll in a Colloquium course during each of their first three semesters. Each program offers a unique course exclusively for the freshmen and sophomores associated with a particular program. This one-credit course counts as a lower level elective. Each course has its own academic focus which explores a variety of topics related to its programmatic theme.
- The Discovery course enables students to learn research techniques by engaging in a research project. Students refine a research question that can be systematically examined. The experience is learner-centered and is not driven by a particular faculty member's research. In the past, the instructional team has included a library faculty member. Some students may choose to engage in community-based research (CBR). One such project involved Lakeland Stars, a program between Scholars and a local elementary school in which the students tutor and mentor children on-campus and at the elementary school. A team of students met with stakeholders involved with Lakeland Stars in order to identify issues that could be explored in an effort to facilitate future program development. See http://scholars.umd.edu/discovery/ for additional information.
- The Capstone experience takes place in the last semester and may involve participation in an internship, a service-learning experience, a research project through the Discovery course, independent study under the supervision of a faculty member, or a student teaching opportunity. Students receive academic credit ranging from one to three credit hours at the conclusion of the experience.

While not all scholars participate in the Discovery project, the Colloquia and Capstone experiences are required for everyone. Beyond these requirements, the scholars' experiences vary, depending on the program with which they associate, since each has its own expectations and

areas of focus. While most students do not have any difficulties fitting the Scholars course requirements into their schedules, it is sometimes problematic for students in majors such as engineering which require a very full course load.

Scholars sponsors an annual Academic Showcase at the end of the year at which the students present their Discovery project posters. Individuals who have conducted an internship or service-learning project also give presentations. In addition, all scholars are encouraged to participate in the University's annual undergraduate research day, either by giving a poster presentation or attending as a consumer.

During the fall semester following their sophomore year, students who satisfy all the Scholars requirements participate in a Citation Ceremony, an event similar to a mini-graduation that is often attended by their parents. Students have an opportunity to reflect on what their two-year experience with Scholars meant to them by completing a commencement survey during their senior year. This evaluation process is conducted in conjunction with the dissemination of a Scholars medallion which is worn at graduation.

Faculty

The faculty who direct each Scholars program tend to be individuals who take an innovative approach to teaching and want to work with undergraduates. Currently, four are full professors and one is a retired faculty member. One program is co-directed by two lecturers, and in another, the director splits his time between Scholars and running a center within the College of Journalism. The level of faculty involvement varies depending on the resources that a college has available as well as on the needs of a program.

Additional Information

The discussion that followed the presentation on Scholars elicited the following information:

Admissions Process: Scholars, like the University's Honors program, is an invitational program. The average SAT score for Scholars students is 1300; their GAP is typically 3.75 or higher. Each incoming class consists of 800 students. The invitation to participate is included in a notification letter in which the applicants are informed of their acceptance to the University. The notification of acceptance and the invitation are deliberately linked so that prospective students can make an informed decision about attending the University. The letter includes information on the twelve thematic programs. In a follow-up letter sent a few weeks later, prospective students are given an interest inventory which asks them to rate which of the twelve programs they would like to join. Each program has approximately 150 first-year and second-year students.

Funding: Sixty percent of the funding for Scholars comes from the Provost and 40% from the individual colleges. These funds are funneled through the Scholars central office, but are managed by each individual program.

Persistence: College Park Scholars has a first-to-second-year persistence rate of 96.7%. Students tend to graduate in four to five years and receive numerous honors.

Research: Approximately 80-100 sophomores choose to engage in research during their final year with Scholars.

Gemstone http://www.gemstone.umd.edu/index.html/

Gemstone was conceived in the mid-1990s by the then Dean of the School of Engineering (now the Provost). Engineering students had great technical skills, but there was a desire to bring these individuals together with students across majors in order to help them improve their communication skills as well as to demonstrate the value that various disciplines add when solving problems. The program, which emphasizes the intersection between technological and social issues, began in 1996. Gemstone is a part of University Honors and is directed at students interested in gaining research and team skills. All Gemstone students are considered Honors students. The average SAT score for these students tends to keep rising; the current average is around 1460-1470. Gemstone is a four-year, invitation-only program. Typically 800-900 students are invited each year to participate in Gemstone, with approximately 170-190 new students accepting the invitation. The program currently has 550 students representing a variety of colleges and majors. Similarly, there is a wide range of disciplinary interests among the associated faculty.

Curriculum

The first year in Gemstone is seen as a time of exploration as students learn about the University and the program. This information is provided to students so that they can make an informed decision about whether or not to continue with the program and commit to joining a research team. Students spend time brainstorming and narrowing areas of interest, as well as investigating the intermarriage of science, technology, and society. All students take GEMS 104, a semester-long course in which they collectively carry out a research project. By the end of their first year they form 8-14 person research teams, all of which focus on a problem involving science, technology and society.

Every team is guided by a faculty mentor and a librarian. The faculty mentors, who are recruited by the Director of Gemstone, receive $5000 annually for their participation, which is considered as an "overload." The faculty mentor and librarian work with their team for three years and are familiar with the core subject area that is being researched.

During the second year, all students take GEMS 202 "Introduction to Research Methodology and Teamwork," designed to provide an introduction to research methodology and give them experience conducting a literature review and summary of resources. Student teams also meet weekly with their faculty mentor (or two times a month for two hours) and engage in the process of exploring and narrowing topics of interest. Every team is assigned an upper-class student who assists in facilitating some of the smaller group discussions. Section leaders are matched with students based on research interests.

During the sophomore year and summer, the student teams go through a formal thesis proposal process and form a committee made up of one-to-two students, the faculty mentor and the Director of Gemstone. The process includes, where necessary, gaining IRB approval for their project by the end of the summer so that team members may begin to collect and analyze data in their junior year. The students carry out the project in their junior year, and in their senior year members collaborate in writing a thesis. The theses usually run about 150 pages. The experience culminates in a team thesis conference which consists of a formal presentation to their team's thesis committee and a larger audience, revision of the thesis based on feedback from a panel of discussants, and submission at the beginning of May. Students receive a Gemstone citation on their transcript and are recognized for their work. The citation requires completion of 18 credit-hours devoted to Gemstone-related activity.

Many Gemstone students have not engaged in conducting original research prior to entering the program. Thus the faculty mentors serve as coaches to the students throughout the process. The faculty mentors develop a close relationship with the students and ultimately

grade their work. Each team is given $300 per year for administrative costs; teams can also submit a proposal requesting more funding. Faculty members have assisted students interested in applying for grants. Grants that have been received in the past range from $10,000-$34,000. Funding is available for students who present their work at professional and undergraduate research conferences.

Additional Information

The discussion that followed the presentation on Gemstone elicited the following information:

Program and Student Information: Gemstone is funded by the Provost through the College of Engineering where it originated. Gemstone welcomes students in business, humanities, and all other majors; 50% tend to be from the hard sciences/technical areas and 50% from the arts and humanities, business and social sciences. Currently, 25% are engineering majors versus the 75% who were involved during the inaugural year. Among the 800-900 applicants who are invited to participate, the largest number are prospective humanities majors. Gemstone is an excellent recruiting tool for the University. Approximately 70-75% of the students are retained in the program from the first-to-second year, and 66-67% remain in the program for all four years.

Living Component: Students are not required to live in Ellicott Hall, the home of the Gemstone Program, though 95% of freshmen choose to do so and many continue through their second year. During the third year a substantial number move to other housing on campus. Classroom facilities are available in the residence hall. Students have an opportunity to get to know one another through classes. The residence hall in which Gemstone students live also houses other students not in Gemstone, thus enabling the students to get to know students outside of the program.

Link with Honors Program: Gemstone is closely linked with the University's Honors program, which is a two-year program and does not have a thesis requirement. An Honors citation requires 16 credits. All Gemstone courses count towards an Honors citation. Three credit hours count towards the University core. If a student decides to go through Honors within a department, which is distinct from the Honors program, he or she may have to write two theses. Most engineers tend to rely on Gemstone curriculum to get an Honors citation.

Discussion

The discussion covered a wide range of topics.

Q: How do you politically negotiate faculty time?

A: The deans do the negotiating. Money from the Provost pays for lecturers to allow for release time for those involved with College Park Scholars.

Q: How can faculty members balance doing research with their program responsibilities?

A: Faculty members have addressed this in a variety of ways. For example, the Honors director has arranged to spend 80% of her time working with Honors and the remaining time on personal research interests. Gemstone faculty mentors are not excused from their regular job responsibilities. There are 40 Gemstone research teams and 40 faculty members from almost every college working with the student teams; 35 are full-time faculty members and the remaining are staff or adjunct faculty.

Q: Has there been support from the Dean, from the start of these programs to now?

A: These programs have transformed the undergraduate student body. Departments and colleges are taxed to help support the programs and pay for the teaching of courses. Funding at Scholars has been constant. The dean and department chairs can do some creative negotiating with faculty time and determining what is extracted from the department.

Q: How different would the programs look if there was not a focus on recruitment?

A: These programs are here to stay. Scholars is currently focusing on pedagogy, course evaluation, and developing universal learning outcomes for the 12 programs. The development of learning outcomes can be a difficult process, given the varying foci of the programs.

A lot of resources are being put into these programs. The University is also gaining a stronger alumni base through attempts that are being made to stay in contact with the graduates of these programs.

Q: What is the relationship between Scholars and Resident Life?

A: Scholars enjoys a real partnership with Student Affairs. The Vice President for Student Affairs is a champion for the program. Day-to day support is also received from Resident Life. The resident assistants (RAs) are viewed as colleagues by the program directors and assistant directors. The RAs are paired with program directors; this relationship allows individuals to stay informed about what is going on in the program and on the floor. Such knowledge can be particularly helpful when issues that arise during classroom discussions carry over into the residence hall. Faculty offices are also located in the residence halls. RAs have been helpful with programming efforts as well. One example is Scholars in New York in which 300 students participate.

Recommendations

- Shared ownership of living-learning communities by colleges, departments, and the provost will encourage faculty involvement. It can be difficult to attract faculty members to take on the responsibility of directing a program. Faculty ownership may be enhanced by marketing these positions as a good training opportunity for future administrative positions (i.e. dean). Relinquishing faculty from other committee work should be considered as well as other measures that would enable faculty to take on additional responsibilities.
- Thought should be given to how holding a program director position could influence interactions with colleagues, tenure decisions, and reviews. A faculty base from which future directors may come could be built through an advisory committee.
- The intellectual ownership of these programs should also be considered. An example was given of a program that moved from one school to another. What impact can these and similar shifts have on the program, particularly on the curriculum and co-curriculum?
- An assessment of the impact of these programs, not just on students' college experience, but on short-and long-term learning outcomes, should be conducted in order to achieve measurable results. These outcomes should also address the strategic plan of the institution.
- Efforts should be made to not disadvantage students who are not participating in learning communities, particularly transfer students.
- The development of research learning communities that are responsive to different approaches to research across disciplines should be considered.

- The impact of learning communities across the span of a student's life in college should be examined.

Resources/References

Websites

1. Education with New Technologies (ENT) is a networked community designed to help educators develop powerful learning experiences for students through the effective integration of new technologies. http://learnweb.harvard.edu/ent/home/index.cfm
2. The Electronic Learning Communities of the College of Computing at Georgia Tech includes links to several computer-based learning environments including AquaMoose 3D, a math learning environment designed to build connections between mathematical and artistic thinking and IRC Francais, a project designed to help students learn French through active conversations with other students. http://www.cc.gatech.edu/elc/
3. The University of Maryland's College Park Scholars is a community of twelve special living-learning programs designed for academically talented first and second year students. http://www.scholars.umd.edu/. See also the College Parks Scholars Discovery Projects: http://scholars.umd.edu/discovery/, and the College Parks Scholars Citation Ceremony: http://www.scholars.umd.edu/current/citation.html
4. The University of Maryland's Gemstone Program: http://www.gemstone.umd.edu/

Breakout Session: Bringing Research to the Classroom within Research Service Learning

Leader: Robert J. Thompson, Jr., Professor of Psychology, Dean of Trinity College of Arts and Sciences, and Vice Provost for Undergraduate Education, Duke University
Recorder: Timothy K. Eatman, Project Director and Research Associate, Imagining America, University of Michigan

Presentation

Linking undergraduate education to the culture of research remains a challenge for major research universities. While establishing this linkage clearly requires formulating a clear undergraduate intellectual agenda, efficient and appropriate infrastructures are also needed to promote quality research-based learning experiences for undergraduate students, measure student learning outcomes and provide a baseline for assessing the "value added" of curricular and pedagogical initiatives. Field-based research and service learning represent two compelling pedagogies of engagement that offer a framework for the required infrastructure.

Employing a case study approach, this session focused on Duke University's "Scholarship with a Civic Mission" program, an initiative funded by the U.S. Department of Education Fund for the Improvement of Post Secondary Education (FIPSE) as a model of undergraduate research at a major research university. In creating the program, Duke adopted a comprehensive approach that was driven by three basic assumptions.

1. The program would be innovative.
2. It would include sound assessment.
3. There would be clear setting of priorities.

From the outset, there was also discussion of crucial issues of sustainability and scaling. The planners were sensitive to the need for resources and the likely struggle to develop among valuable but competing efforts to gain them. They determined to align their efforts with an institutional self study that was done as part of the accreditation process in order to maximize the energy and resources allocated to both efforts.

Several important questions emerged that served as a refrain in the planning process:

- What drives research learning?
- What is the appropriate context that frames undergraduate research?
- How do we come to make work?

The architects of the program accepted the challenge to maintain a focus on formulating an *intellectual agenda* as a framework for the process.

Finding it useful to revisit the philosophical underpinnings of liberal arts education while at the same time avoiding the common semantic triteness of much higher educational policy and practice, the architects were guided by a working definition of liberal education: "to empower the individual by expanding the capacities to reason and empathize by developing intellectual skills, ways of thinking, and practices of inquiry." The integration model (see below) captures the importance of balancing the fulcrum between education and research. Developing an undergraduate research program that is consistent with university curriculum standards resonates with this goal.

As a result of result of this philosophical clarification and a comprehensive needs assessment, the decision was made to revise the existing undergraduate curriculum so that it would be student centered and include the development of learning agendas, worthy educational objectives, meaningful competency assessments and pedagogical approaches that add value to the undergraduate learning experience in general. Facilitating cross cultural exposure and literacy was seen as contributing to these aims by helping students achieve positive identity change—an understanding of how as citizens they can make a difference in the world--and a rich sense of civic agency as they commence from university life. The pedagogical approach to be used would involve practices of inquiry couched in experiences that facilitate personal development and lead to the development of interpersonal skills that complement intellectual skills.

The persisting and underlying interest was to achieve two goals:

- To establish an undergraduate culture of research.
- To establish interdisciplinary, inquiry-based undergraduate education as the distinctive signature of Duke University.

Like other research universities, Duke is well suited to achieve these goals. Other related objectives included increasing the number of students who complete research experiences and increasing the number of students who completed an honors thesis (Graduation with Distinction). It quickly became clear that meeting these goals and objectives required both curricular and pedagogical changes. Indeed,

"the curriculum is the scaffolding to accomplish the intellectual agenda of the institution."

The new inquiry-based curriculum was developed using a combination of new and existing courses. The cornerstones for these courses are writing and research. Students are encouraged to read critically, join and initiate intellectual conversations, and develop sound research skills. Class sizes are limited to twelve, a reflection of the University's serious commitment to quality interaction.

"Scholarship with a Civic Mission," a faculty-led collaboration between the Kenan Institute for Ethics and Hart Leadership Program and the Trinity College of Arts & Sciences project, was established to advance this intellectual agenda. Features of the program include:

- A three-stage model for research service-learning (RSL)
- Opportunities for undergraduates to design and pursue research that addresses community needs and interests
- Supported from a three-year, $454,000 FIPSE grant
- An additional goal: To build sustained community partnerships

Students are required to take two research courses to prepare for engagements with community partners. It is interesting and pleasing to note that students were the impetus for the experiential component of the course.

Discussion

Participants in the session represented a variety of intersecting interests. The main shared interest was a desire to learn about ways institutions are connecting research to service learning. They were also eager to learn how service learning affects students in general and with regard to various academic disciplines, how to promote community-based research, and logistical and operational details of the program. A question was raised about how students learn about the program and what it is that attracts them, given the array of flyers students typically receive about initiatives on a campus. At this stage there is no one particular moment when the students are informed about Scholarship with a Civic Mission. There has been, however, a focused effort to train academic advisors to communicate the opportunity.

Forming good partnerships with community institutions is essential, particularly when students are identifying and developing their projects. At Duke, this process takes place during the capstone phase, when students work with the program coordinator and an agent from the community partner institution to determine their projects. They then develop them through a flexible interdisciplinary and departmental pathways model and an independent study course option that exists for all courses at Trinity College. Although concern was expressed about the difficulty students might have in coming up with projects that align with their major in a natural science, for example, the Duke model has proven flexible enough to accommodate the range of disciplines.

The Scholarship with a Mission program appears to be working well, based on several measurable outcomes:

- Gateway courses have involved twelve departments and 636 students
- Sixty-one students have pursued Stage-Two community-based research with partners in Durham, Charlotte, Albuquerque, Chicago, Mexico, Peru, Kenya, Namibia, and South Africa
- Thirty-eight grants have been awarded to students, faculty, and community partners
- Students have presented their work in local, national, and international settings
- Faculty have given more than twelve presentations at professional and educational forums

The FIPSE grant has been used to support faculty summer programs, community partner activities, and student projects.

In addition to the above descriptive data, the program's effectiveness is also being measured through surveys of students and faculty about their experiences in their community-based and other associated courses. The surveys have found that students enjoy their Gateway courses more than other courses they have taken and, in comparison with their peers, respond more favorably to "real world" issues and challenges of moving outside comfort zones. The University is maintaining data bases with information on students' acquisition of skills and progress in the program. One goal is to determine if students in the program are actually learning more than their counterparts, rather than simply thinking they are learning more. Based on the evidence so far, students do not think that the Scholarship with a Civic Mission courses require more work than their other courses, but they do think they are more stimulating.

While recognizing the value of the Scholarship with a Civic Mission program, participants raised several questions: Does the self-selective nature of the program attract students who are predisposed to intellectual engagement? If so, how does this relate to the success of the program? Do students taking Gateway courses learn more than students in traditional college courses? Does the increased "stimulation" of the courses lead to greater engagement and increased learning?

Recommendations

For Individual Campuses

- Effective initiatives will need to connect with larger institutional goals and existing University commitments. Establishing connections requires investigating where potential projects exist and discerning who is already doing the work.
- The upper administration and departments need to develop incentives for faculty by finding ways to link engagement to teaching rather than relegating service to the traditional standard review processes.
- Tag existing courses for redevelopment.
- Enhance the focus on assessment.
- Go beyond the natural pool - get to the students who may not be inclined to register for these types of courses, but would really benefit from them.

For The Reinvention Center

- Identify opportunities for inter-institutional collaboration by coordinating inventories and sharing information about actual topics, curriculum and assessment methodologies.
- Connect where there are existing commitments. Investigate where and who is already doing the work.

Resources/References

Website

The Duke Scholarship with a Civic Mission project gives students, faculty, and community groups a chance to work together on issues of common concern. For more information visit: http://rsl.duke.mc.duke.edu

Breakout Session: Research as an Integrative Experience

Leader: Lee Willard, Associate Dean, Arts and Sciences and Trinity College, Duke University
Recorder: Jeannie Brown Leonard, Graduate Student, Interdisciplinary Studies, University of Maryland

Presentation

This session provided participants with a comprehensive overview of how one institution, Duke University, is systematically changing the institutional culture to embrace research as a central component of its undergraduate education. In her opening remarks to the Reinvention Center 2004 Conference, Nancy Cantor shared her view that a commitment to undergraduate research can be a catalyst for institutional change. This is precisely the approach that Duke is taking. Undergraduate research is becoming the defining concept at Duke.

Institutional Background

Since 1995, Duke has been taking an integrative approach to enhancing undergraduate education. Key developments have included:

- Establishing the East campus as the first-year undergraduate campus (1995)
- A curriculum review process that led to a systematic overhall of the undergraduate curriculum (1997)
- Implementation of a new residential plan for upper level students (2002)
- Re-evaluation and simplification of the new curriculum (2003)
- Active assessment of the curriculum and examination of learning outcomes (current)

These comprehensive efforts are promoting a change in institutional culture that is focused on undergraduate education and research. The energy and success of these efforts have been possible in large part because of the shared institutional vision for undergraduate education at all levels – the "harmonic convergence" of people, vision, mission, values, and rewards.

Duke's reform effort is grounded in the University's definition of liberal education and the overarching institutional educational philosophy. At Duke, the goal of liberal education is "to empower the individual by expanding the capacities to reason and to empathize by developing intellectual skills, ways of thinking, and practices of inquiry." As an extension of this mission, Duke embraces the belief that "The strongest educational advantage offered by a research university is to connect undergraduate education to the processes of inquiry and discovery." As Duke's faculty grew in size by nearly 100 over the past twenty years, the University's research reputation soared. New majors and academic centers were added, as were new facilities and laboratories. This research-centered growth has provided a natural foundation for enhancing undergraduate experiences and connecting undergraduate students with faculty through the research enterprise.

Duke's recent institutional development was encouraged by its 1998 SACS Reaccredidation Self-Study, "Balancing the Roles of the Research University" which posed such questions as: What is the role of research? What is the role of education? What is the role of graduate students? What is the role of undergraduates? As the campus struggled with the tension between the often-competing demands of research and teaching, the institution realized we must creatively realign the two. Rather than a linear educational model with teaching on one end of the fulcrum and research on the other, the University recognized the need for a more integrated model:

A new liberal arts curriculum offered the vehicle to prompt this broad institutional change. A seminal curriculum review determined sets of intellectual and personal development skills, as well as epistemological skills Duke sought to cultivate. Intellectual skills include critical thinking and reasoning; the ability to analyze, integrate and synthesize information and ideas; problem solving; the ability to formulate and support an argument; and quantitative and scientific literacy. Skills in the personal development arena include interpersonal skills, cross cultural literacy, civic and moral responsibility, the ability to collaborate and compete, and self-regulation (i.e., taking charge of one's own education, being able to assess what one is good at). Evidence of epistemological sophistication include abilities to inquire, generate knowledge and understanding; bringing meaning to information; learning to discern among competing claims; and translating knowledge to address pressing social problems.

In the Fall 2000, Duke implemented its interdisciplinary, inquiry-based curriculum, dubbed "Curriculum 2000," now called the Trinity College curriculum (see: www.aas.duke.edu/trinity/t-reqs/curriculum/index.html). The curriculum is framed around five areas of knowledge (Arts, Literatures, and Performance; Civilizations; Social Sciences; Natural Sciences; and Quantitative Studies) and six modes of inquiry (Cross Cultural Inquiry; Ethical Inquiry; Science, Technology, and Society; Foreign Language; Writing; and Research). It merges general education and the major, allowing a single course to fulfill several requirements simultaneously. Of particular note is the requirement that every student engage in two "research" (designated 'R') courses (see below); this requirement signals the importance of research as an institutional priority and the intention to shape an undergraduate student culture that embraces research.

Emphasis on Undergraduate Research

Duke is integrating research into the curriculum by providing access for students at all levels: in the first year though the FOCUS Program and first-year seminars; in the middle years through the especially-designed "research" or "R" courses, course clusters, summer research opportunities, and other initiatives; and for seniors through capstone experiences, certificate programs, and graduation with distinction.

Year One

The FOCUS Program (see http://focus.aas.duke.edu//) is Duke's signature first-year program. This living/learning community provides clusters of seminar courses around a shared theme, such as "Mind and Brain," Forging Social Ideals," or "Arts in Contemporary Society." Active learning and participation is encouraged in these courses that limit enrollment to 18. Students are able to learn in depth about an area of interest and develop the analytical tools to become research scholars. Systematic reflection is incorporated, as are creative assignments. Approximately 25% of Duke's first-year students participate in this research-intensive experience.

The First-Year Seminars (see: http://pmac.aas.duke.edu/trail/seminars.html) offer a less intense option for first-year students to gain research experience. Similar to the FOCUS courses, first-year seminars are small and taught by distinguished faculty. They are designed to help students make the transition to the academic life at the University. Seminar topics vary widely; examples include "Sea Change: Human Interaction with a Changing Ocean," "Controversies in African American History," and "Tales of the Road: Travel Narratives and Russian Culture."

Years One through Three

"Research" or "R" courses (not limited to year) are especially-designated courses designed to teach students how to formulate a question, analyze material, and integrate findings. Though their content varies enormously, research courses have common elements: All students must complete a paper, poster session, performance, or product that demonstrates their acquisition of the required skills, as well as an understanding of how knowledge in the discipline is generated, organized, and presented. Current R-courses include such diverse subjects as "Poetry and the Healing Arts," "Digital Durham," and "Experimental Cell and Molecular Biology."

Thematically-related course clusters enable students to build on and extend the early strong foundation obtained in the FOCUS program and first-year seminars. Clusters provide a pathway so that students can construct an integrated and meaningful curriculum.

Research Service Learning enables students to conduct research and reflect on a community-based problem. The RSL paradigm consists of a foundational course, followed by a summer research and service experience, and then a reflective course.

Year Four

Capstone courses for seniors provide a culminating experience.

Interdisciplinary Certificate Programs (see: www.aas.duke.edu/trinity/t-reqs/majors.html#Programs) represent another option for students, providing capstone courses that build on foundational courses and elective work. Certificate programs offer in-depth, interdisciplinary study and are available in a wide range of areas, including "Markets and Management," "Film and Video," and "Human Development."

Vertical Integration Teams (not limited to year) of faculty, graduate students, and undergraduates create rich opportunities for undergraduate research. In this model, graduate students mentor undergraduates and direct undergraduate research projects under the guidance of a faculty member who serves as "team leader" of the partnership.

As a critical component of its research emphasis, Duke provides several venues through which students showcase their accomplishments. These include:

- A student website, portfolio@Duke, has become the repository for a wide range of work students decide to present (see: https://portfolio.oit.duke.edu/index.jsp).
- An undergraduate research symposium, "Visible Thinking," is tied to a major campus visitation day for accepted students. Participation in the research day has doubled in the past three years (see: http://www.aas.duke.edu/trinity/research/vt).
- Companion programs in fine arts departments and in departmental honors programs are coordinated with the Visible Thinking symposium, providing a concentrated celebration of undergraduate research over several days.
- A student-led, Tri-University Research Symposium (Duke, University of North Carolina-Chapel Hill, and North Carolina State) showcased student projects and will be expanded to a state-wide event through external funding.

The Vice President for Undergraduate Education is working closely with departments and interdisciplinary research centers to develop additional course opportunities that offer inquiry-based learning and undergraduate research. Cultivating funding sources to support student research also is a priority. The University is significantly raising expectations and goals for the proportion of its students that engage in undergraduate research. In 2003, 29% of the students completed an undergraduate research experience. In 2004, 34% had this experience, mostly through independent studies, and the University has targeted a goal of 50% participation in the coming years. Another challenge stems from the fact that comparatively few students complete an honors thesis to graduate with distinction (11% in 2001 to 13% in 2004). The University would like to see 25% of the students pursuing honors designation and is working to that effect.

Duke is currently engaged in a significant assessment effort. Moreover, undergraduate research was the topic of the recent meeting of its Trinity Board of Visitors, the College's advisory body, where that group examined how the institution communicates the value of research to current students, alumni and admissions, development, and career center/employers.

Discussion

Discussion centered on the strategies and process through which Duke initiated and implemented curricular change to focus attention on undergraduate research and on the specifics of its various innovations. Duke was able to accomplish these changes organizationally because of the leadership of the Vice Provost for Undergraduate Education and the support of the Office of Undergraduate Research. The Dean of the Faculty of Arts and Sciences shares this vision, and issues related to undergraduate research are raised in staff and budget discussions. Current efforts include trying to endow fellowships to support student research and encouraging more faculty to mentor undergraduates in their research.

Questions were raised about the 'R' courses. Criteria for designation as an "R" course include asking questions, assembling evidence, and producing a product. Understanding process is a key skill in these courses, as well.

The library plays a central role in supporting Duke's undergraduate research emphasis. Efforts are being made to expand its involvement and to better connect faculty to library experts to help develop resources to support departmental teaching through research.

The University is also addressing issues of faculty load and reconceptualizing advising. Faculty who are involved with undergraduate research advising describe it as energizing, but some faculty are, at first, reluctant to get involved. We need to craft stronger and clearer messages to recruit more students and faculty to the honors experience.

Changing the institutional culture so that undergraduate research is at the center poses many challenges. The University is seeking to link institutional funding for research centers to its commitment to the undergraduate mission. This leverage is prompting the centers to develop undergraduate programs and certificate programs in key areas such as Genomics. Duke is also considering providing research opportunities related to the study abroad experience.

Recommendations

- Campuses should consider making a transcript notation to recognize and celebrate students who have completed significant undergraduate research. Individual institutions might need to work with their Registrar to determine if such a notation is possible and work with faculty to determine the criteria for such a designation.
- University leaders need to place the commitment to undergraduate research at the center of the university's mission.
- Working together, administrative leaders and faculty should create multiple outlets for research and begin grooming students for this experience in the first year (or even as prospective students) by setting research expectations early. By engaging students in a sequence of academic experiences from first-year seminars to capstone courses, a university can establish an undergraduate research culture.
- Students should be given the tools for research early and invited to apply these tools throughout their college experience. Asking questions is an important skill. As a Duke undergraduate student said, two critical questions are "How do I know?" and "Why should I care?"

Resources/References

Websites

1. Trinity College curriculum: www.aas.duke.edu/trinity/t-reqs/curriculum/index.html
2. The FOCUS Program: http://focus.aas.duke.edu//
3. The First-Year Seminars: http://pmac.aas.duke.edu/trail/seminars.html
4. Interdisciplinary Certificate Programs: www.aas.duke.edu/trinity/t-reqs/majors.html#Programs
5. Student website, portfolio@Duke: https://portfolio.oit.duke.edu/index.jsp
6. Undergraduate research symposium, "Visible Thinking:" http://www.aas.duke.edu/trinity/research/vt.

Breakout Session: Technology and Pedagogy: Faculty Development's Piece of the Undergraduate Research Puzzle

Leaders: Renata S. Engel, Professor of Engineering Design and Engineering Science and Mechanics and Associate Vice Provost for Teaching Excellence; Valerie C. Dudley, Graduate Student, Department of Instructional Systems; and James Thurman, Professor of Art and Associate to the Director, School of Visual Arts, PennsyIvania State Univerisity
Recorder: Valerie C. Dudley

Presentation

Motivation and Background

This session was designed to generate discussion about approaches that can be used to affect curriculum change so that research, research-based activities, opportunities for creative expression, and discovery can be embedded at all levels, across all disciplines in undergraduate programs at research universities. A curriculum shift to inquiry-based learning requires a certain degree of institutional support, the interest and commitment of faculty, and the partnership of faculty developers to provide tools and approaches. The presenters in this session provide background information on the institutional role, the faculty role, and the faculty developer's role in curriculum reform to embed inquiry-based learning in undergraduate courses.

The Approach

Inquiry. Creation. Discovery. Understanding. Advancement. These words characterize the world of research and the key ingredients in deep learning. A vibrant undergraduate research and creative accomplishment program would allow students to experience for themselves the importance of *inquiry*, the intellectual demands of *creation*, the excitement of *discovery*, the awe of *understanding*, and the tremendous sense of accomplishment in the *advancement* of knowledge.

Support for undergraduate research at the institutional level makes good sense and practice because the value cuts across disciplines. Research embodies the excitement of learning. It is an integral part of each faculty member's own preparation and educational background, and the lessons learned by students prepare them for a life of learning. The degree of institutional-level support is highly dependent on the institution; however, certain elements of support can be identified that are applicable across institutions. For example, mechanisms must exist to promote the importance of research to undergraduate students and the public. Students should see and experience for themselves the value of learning from those who are the creators of knowledge, new interpretations, and new ways of experiencing or applying technologies. The work of faculty to engage students in research and provide them with educational experiences that develop the skills associated with research must be valued.

The traditional methods of providing research experiences for undergraduates are either one-on-one experiences via internships and independent studies or research methods courses, such as laboratory experiences within a class context, data analysis courses, and design of experiment courses. These are extremely rich with excellent opportunities. They allow students to participate in long-term projects, to refine skills and provide increased opportunities for reflection and evaluation of results. However, those opportunities and courses are not available to all students, nor do they provide motivation for students to consider research as an intellectual activity that they identify for themselves. The impact on student learning can be profound if we consider ways to bring research into the courses students take so that they can build their research skills in a variety of subject matter. In so doing, the one-on-one experiences that they may encounter intermittently throughout their studies or as a capstone experience have the potential to be much richer.

Different approaches can and should be used for the variety of courses taken by students. Effective approaches exist to embed research into many of them. Seminar-style courses and discussion-based courses, for example, provide wonderful contexts for students to develop a thesis statement and formulate arguments to support it. General education courses are ideally suited to include an array of primary source documents. Sometimes, they give students their first opportunity to work with these documents and gain understanding of the distinction between primary and secondary sources.

The Schreyer Institute for Teaching Excellence

Organizationally within Undergraduate Education and International Programs, the Schreyer Institute for Teaching Excellence is dedicated to enhancing undergraduate education at Penn State through all aspects of the teaching and learning process, including course development and implementation and learning assessment. Its staff, made up of twenty

full-time and nine graduate assistant employees, assists faculty at different stages of their teaching career through workshops, seminars, funding, consultations, and assessment activities and by making available to faculty a vast array of resources, print and online. The staff also contributes to the scholarship of teaching and learning and introduces faculty to new and different tools and techniques.

The InSpire Academy

The InSpire Academy was created by the Schreyer Institute in order to provide faculty with the tools and techniques consistent with their disciplines and appropriate for the level of courses they teach. It is a competitive program open to all Penn State faculty who are interested in bringing their research and creative accomplishments to the undergraduate classroom as a way of stimulating student interest and encouraging them to further research. The Academy consists of a series of workshops and working sessions designed to take faculty through the design and assessment processes, give them the opportunity to work with faculty from other disciplines and learn about the "best practices" of faculty in similar fields.

An Example

James Thurman, Assistant Professor and Associate Director of Visual Arts, was teaching a course in Penn State's metal sculpture program. Because the program is not in a traditional art field, the course was not attracting enough students to maintain vitality, nor did it have the recognizable or visible presence of other programs in the college. Professor Thurman turned to the InSpire Academy for assistance. Although his goal was to broaden interest in the metal sculpture program, he also saw curricular revision as an opportunity to build contemporary approaches into the students' activities.

The curriculum revision would have to be developed in the context of new directions in his college. An opportunity existed in the area of digital technologies where students could not only learn about contemporary methods, but they would also be able to explore their own techniques, learn from one another, and be exposed to technologies that would cut across other art fields.

Before undertaking major curricular change, Professor Thurman worked closely with an undergraduate student who expressed an interest in making her visual art accessible to the visually impaired. Using her project as a test case for applying new approaches and technologies, he provided her with tools to explore various three-dimensional printing options. The student's research on the catalyst and rapid prototyping methods, an established technology in engineering, became the mechanism for exploring visual art for the visually impaired. Professor Thurman expanded her work by exposing students in a sophomore-level undergraduate course to contemporary methods while exploring haptic (touch) expression.

Consider two photographs shown in the figure. Shadows, reflections, sharp edges, contrasting textures dominate the images. Imagine how you might make the images accessible to the visually impaired. Using rapid prototyping devices, the students explore correlating the gray-level intensity to the height of a three-dimensional object and investigate how that haptic response for the visually impaired is related to the visual response for the sighted.

InSPIRE Academy: The Way It Works

Research projects like the one Professor Thurman embedded in his course are ideal for undergraduate student involvement and exploration. The InSPIRE Academy is structured for faculty like him to share ideas and effective approaches and to develop a network of colleagues who are interested in embedding research into their courses, regardless of the discipline or the level of the course.

Faculty apply to the Academy by submitting a proposal that identifies a specific undergraduate course which would benefit from the incorporation of inquiry (research) and creative expression activities. Their application also includes a support letter from the department chair describing the faculty member's research and teaching contributions to the department and indicating how the changes to the course could impact other courses in the department.

The Academy is comprised of four workshops in which the faculty members work closely with course and curriculum consultants at the Institute to develop materials for their courses. The one-on-one sessions of faculty member and consultant facilitate the process. The first workshop focuses on the methodology for integrating research experiences through inquiry-based learning. Faculty members are guided through an integrated design and assessment process, which includes participating in activities that help them determine the learner characteristics that their students possess and the concepts and skills they want their students to master through the course. Faculty end this session with a homework assignment designed to prepare them to develop learning goals and objectives for their course.

In the second workshop, faculty members focus on defining course objectives, and learning goals. This session guides faculty through the problem development phase of course planning for Inquiry-Based Learning (IBL) and provides them with an opportunity to develop a problem/activity that would be ready for use in their course. Working with their consultant they begin developing an instructional plan for their course using IBL.

The third workshop focuses on how to use learning goals and objectives for the course to inform the design and assessment of student learning. In this session faculty learn about different methods to assess inquiry-based assignments. They also work with their consultant to develop a grading rubric for their assignments. This workshop includes an opportunity to develop an on-line instrument to obtain student perceptions on how inquiry-based learning is helping students learn.

The fourth workshop focuses on the development and creative use of "traditional" forms of testing and measurement. In this session faculty discuss ways to use different assessment techniques to address their course objectives and goals. Faculty members are guided through the process of writing effective test questions that tap higher order cognitive skills. To end the session faculty members design an assessment plan appropriate for their course.

One of the tools that the faculty are introduced to early on is the TGI- the Teaching Goals Inventory. The tool provides faculty with an organized approach to identifying the most important goals that the faculty member wishes to achieve in the course. It also helps the faculty member to distinguish between essential and non-essential learning goals since each goal must be ranked from 1-5 based on the faculty member's view of what they want students to be able to accomplish in their course.

The TGI has a 52-item inventory that faculty must complete for a given course. The faculty responds to each item in six categories: higher-order thinking skills, basic academic success skills, discipline-specific knowledge and skills, liberal arts and academic values, work and career preparation, work and career preparation. Once the inventory is completed, it is easy to rank the categories based on the number of essential items in each category as well as the average rating for the cluster. From the work that Professor Thurman did during the workshop, he identified "discipline specific knowledge and skills" as the most critical, followed by "higher-order thinking skills."

Through the use of the TGI, Professor Thurman was able to develop new assignments and projects that reflected his newly-identified priorities. One example is his introduction of a sketchbook requirement as a means for recording brainstorming and design activities. This journal or diary is regularly reviewed and evaluated to encourage the students to examine the course's subject matter and improve their higher-order thinking skills. New evaluation rubrics were also created and distributed to the students upon the completion of each project. These rubrics further emphasized the mastery of discipline specific knowledge and skills and provided the students with concrete feedback on their progress.

Summary

Faculty participating in the Academy span the sciences, social sciences, humanities and arts. They have incorporated new approaches into general education as well as discipline specific courses. Enrollments in classes supported by the Academy have ranged from 20 to over 100. In addition, this program has appealed to faculty at several campuses within the Penn State system.

Discussion

Session participants examined a number of issues that emerged in the presentation.

Students need to understand an instructor's objectives when a significant change is made in the way the instructor presents material. If the objectives are conveyed clearly and are well understood by the students, students feel empowered and many barriers that prevent them from learning are removed. In the case of Professor Thurman's course, the new technology of three-dimensional printing was not familiar to the students. Embedding it in the delivery and the course expectations had the increased value of exposing them to techniques that enhance the work and improve the efficiency of creation. This frank and honest communication between faculty and students can give students a feeling of ownership in the overall learning experience. Students may also be more tolerant of changes or revisions since they are a part of the ongoing development of the presentation of the subject matter.

Considerable discussion focused on the value of exposing students to multiple-choice questions as a way of initiating classroom discussion. The questions should be constructed to reveal misconceptions by the students or offer alternative perspectives that should be examined. When multiple choice questions are used for testing purposes in courses that include research, the test should include questions that examine understanding of concepts questions as well as high-order skills, such as integrating and applying concepts to unfamiliar situations.

Faculty qualifications were discussed and several important observations were made: 1) Faculty must be engaged in research; 2) even though some faculty like Professor Thurman can 'make toast interesting,' the techniques and approaches presented in the Academy must work for a range of faculty styles; 3) team approaches can be highly effective, particularly when showing the collaborative side of research.

Extensive course revision and innovation is a very intensive and time-consuming experience and one that does not fit the mold of traditional reward structures. Inviting faculty colleagues into the class to observe may be one method of introducing them to the learning gains achieved by the students as well as providing a valuable peer evaluation opportunity. Good documentation and support from the administration are also valuable. In many instances, these new approaches may be seen as representing a major shift from the dominant mode of teaching within a field. In order for this shift to take hold, faculty members initiating the changes need to be supported in their efforts. If they are not supported, their work may be seen as an unproductive distraction.

Recommendations

- Teaching resource centers and individual faculty should use a teaching skills or goals inventory for faculty and students when implementing a course/curriculum revision to integrate research into a course.
- Campuses should develop a process that allows faculty to share their best practices for integrating research and research activities into the undergraduate curriculum.
- Instructors should use multiple-choice questions to stimulate class discussion. Where possible answers must be constructed to provide room for stretching student's thinking.

Resources/References

Websites

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Breakout Session: Bringing Research into the Classroom within the Performing and Fine Arts

Leader: Donald McKayle, Artistic Director, UCI Dance, University of California, Irvine
Recorder: Amanda Nora, Graduate Student, Department of Dance, University of California, Irvine

Presentation

The session began with all those present explaining their reasons for attending this particular session and describing briefly their questions and concerns about the status of arts education and research at universities. Although their responses revealed a wide range of interests, there were some common themes that were expressed by almost

everyone: "Art research is not getting enough funding at my research institution because the grant committees do not find it important;" "My research committee has not received any arts applicants; how can we reach out to get some of those people?' 'I want to find some possible strategies on how to educate and illuminate to members of research committee what it is that artists do so that they may not only fund it, but also support the research process and come see the presentations;" "As a committee member, I want to learn about what it is that artists do;"' 'How can artists attain the language necessary to talk to non-artists about the research their work involves, what it is that they do, and why it is important?' "I am interested in a broadening of what undergraduate research includes;' "Sciences are like a 400 lb. gorilla, ready to soak everything up, and the arts are not getting as much funding."

Session leader McKayle provided information on his own background, which shapes his interest and perspective on many of these issues. He is a professional choreographer and director who has been a professor at the University of California, Irvine since 1989. Before that he was Dean of the School of Arts at Cal Arts and before that taught at Sarah Lawrence, Bard College, and Bennington colleges. He has also choreographed and directed movies, Broadway shows and concerts for dance companies all over the world. He is equally at home in the world of academia and in the world of professional dance.

At the University of California, Irvine, creative work and research work in the arts are considered equal. In dance at Irvine, for example, the hours and hours spent rehearsing, choreographing, staging, and performing are recognized as "research." Every year students in the arts apply to the University's Undergraduate Research Opportunity Program (UROP) for support of their creative activity "and get money." Thus Irvine's faculty and students in the arts do not have some of the burdens that their counterparts at other universities have. The equalization of creative and research activity even extends to the hiring and assessing of faculty.

Using his own experience as a backdrop, session leader McKayle focused the discussion "on the dual role of arts education in the research university: the creative act and the examination, analysis, and study of the creative act." Issues that need to be addressed, he noted, include: Maintaining "balance between creation and scholarly pursuits, the acquisition of skill in the practice of the arts as pursued by the arts major and by the non-major, and the establishment of forums for presentation in the arts as an integral part of the creative experience."

Discussion

The rigorous and open discussion that followed began with the "400 lb. Gorilla" of the sciences and a consideration of strategies to decrease its hold and create more opportunities for undergraduates in the arts. One approach is to make the university's undergraduate research office a centrally-administered campus-wide entity with a mandate to respond to the needs and interests of students in all departments and majors. One campus accomplished this by moving the office from the science building in which it had been housed to a central location. A session participant who oversaw her campus's undergraduate office offered a more personal and subversive strategy, which was to rank proposals during a funding "round" so that 75% of those funded went to arts and humanities majors, rather than to science students who traditionally dominated the awards. She very carefully did not formally acknowledge this practice as official policy, but rather kept it quiet as a priority for herself and the office. Other session participants who served as members of research committees indicated that they too had engaged in similar efforts, both formally and informally. Some undergraduate research offices have created Web sites that describe funding and grant opportunities and also present final reports on prior projects to promote awareness and education. If an outstanding student project in the arts is on display for people to see, then artists, committee members, and sponsors are more likely to be interested in arts research projects. Moreover, those who funded that particular project feel proud to have helped facilitate its fruition.

Some undergraduate research committees have adopted a policy of funding faculty mentors who supervise student projects. The faculty may for example get half of the money awarded. Committees that award funds to faculty for supervising undergraduates emphasize the importance of these faculty acknowledging, supporting, and giving credit to the undergraduates. Too often, students do a significant portion of research for a faculty project, but when the work is presented, the name of the faculty is front and center while the name of the student is nowhere to be found in the credits. Faculty are encouraged to give students proper credit for their contributions, and, if possible, to use grant funds to pay them for their work. This is a common practice in the sciences. Students should not be viewed simply as "add ons." They should be included and recognized for the role they play.

How research-oriented proposals in the arts are put forward and how they are presented and received can be very important. One example given was of a stage design project, which was an exemplary creative work. The student responsible for the design, the faculty supervisor, the relevant department and the university undergraduate research office all worked to promote this project by presenting it across campus and at project fairs. Their efforts led to widened awareness of the arts, made the sponsors proud and excited to have helped fund research in undergraduate education, and provided exposure and empowerment for the student and his outstanding work. To this day, when discussing research in the arts, committee members mention this project and how wonderful and useful it was.

Bringing in significant, successful artists from the field to work with students on their research and creative endeavors is a good way to get the community involved and also stimulate interdisciplinary interest. Conversely, facilitating presentation of high-quality student art work in well-established community venues allows for the students to be reviewed and discussed in larger forums than their immediate peers in their major can afford; it also increases community awareness of the arts in education.

One session participant organized a symposium to display research work in the arts, but nobody came. The challenge is how to attract people from other disciplines to events in the arts. What is the purpose in holding such events if there is no interest? Some members require students enrolled in related courses to attend these kinds of events. Some encourage attendance by entering students who go in a raffle for a gift certificate to the bookstore. Some campuses have multi-disciplinary events and give awards in different categories to the best projects, thereby ensuring broad attendance.

How are creative efforts evaluated, and what counts as research in artistic disciplines? One student who received "research" funding was an art quilter who planned to interview the best quilters in the world. Members of the undergraduate research committee had great difficulty in assessing her proposal because they thought about quilting in a traditional, outdated sense, wondered about the implications of the proposed research and wondered also about its relevance. They awarded her funds, though with some misgivings. It was not until the committee members attended a student show where the student's three-dimensional quilt was hanging that one member could under-

stand quilting "beyond her grandmother's closet," and see the ways the student had drawn upon information gleaned from the interviews in creating her own work.

A question was raised about the proposal process, which often plays a hand in encumbering and stunting the growth of undergraduate research in arts education. Some artists have an idea for a project, but they do not know how to write a proposal, which requires that they describe and explain the importance of the project, often in terms of criteria which seem unrelated to their work. As one participant asked, "Why do I have to justify why my art is important?" Many art students do not know how to articulate, even to other artists, what they do. They have neither the language nor the perspective to acknowledge the purpose in explaining the creative process and project work. For some, explaining the methodology of what they propose to do runs counter to the creative process and "takes the 'art out of the project:" "The magic goes away if we talk about it."

Getting artists, faculty and students to talk candidly about the progress of their projects is a difficult task. It requires having critical insight into what is working and what is not, what was planned and what was not planned, and what are some of the unexpected challenges that have come up. How will the artist troubleshoot these difficulties? Perhaps because of society's persistent undervaluing and under funding of the arts, artists have often assumed a defensiveness about what they do. Some fear that admitting problems and/or fundamental steps that are taken in creative works may weaken their already faltering position.

Like their students, faculty in the arts also have difficulty with the language and structure of proposal writing. University campuses and the Reinvention Center should hold workshops on grant and proposal writing for both students and faculty in the arts. On campuses, such a workshop could be an interdepartmental effort, with a general session directed at all participants and separate sessions or forums directed at specific disciplines. The content of all the sessions, including questions and answer, could be posted online for access by all interested students and faculty. As a follow-up, after the workshop, a recap and review paper can be issued and posted on the Web to serve as a reference for faculty, students and administrators, including those who were not able to attend the workshop. Another option is to bring in a grant writing consultant to provide guidance and education on the language and skills necessary to talk about arts to non-artists.

A session participant asked, "Who are we targeting?" What do we in the arts do with research dollars? Do we use the money just to go after the elite at our universities, those who do artistic things very well, or to show people that art is essential to everybody? Session leader McKayle noted that educational values are now, to a great extent, being set at the national level and trickling down. This represents a major challenge because the "No child left behind" initiative, which is a major force in elementary school education, does not include the arts in education. How can artists and arts educators change this paradigm? The arts in primary and secondary education are the first subjects to be cut because they are seen as adjuncts to a good education and unimportant in "this culture" (North American).

The group agreed that educators in the arts need to address several questions:

- Perhaps most fundamental is, "what does it mean to do research in the arts?" How do we define the methodology of arts research? Such definition will require gaining understanding of the milieu that underlies a creative endeavor; gaining understanding requires research to acquire knowledge of the culture, tools, traditions and other variables that influence the artist.
- What are the criteria by which research in the arts is evaluated? Session leader McKayle suggested that arts faculty and professional staff look to a range of models of art research to determine how the research and creative work of arts faculty is evaluated in hiring and tenure reviews. Campuses implicitly or explicitly have established standards for faculty in tenure track positions. What does "research" mean to non-arts faculty who vote on promotion and tenure? He suggested using the same sort of standards they use when considering funding, and evaluating art research in undergraduate education.
- How do we show that art is essential in undergraduate education? In North American society? In the "War on Terror?"

Through a bold attempt to aid exposure, promotion, and education of the arts and by making clear its relevance and its essential role in a quality liberal arts education, faculty and professional staff in arts departments, working with undergraduate research offices and senior administrators, can raise the visibility and status of the arts campus wide and also assert its societal value.

Recommendations

For Individual Campuses

- Universities should look beyond their own campus and create opportunities for their students to present their research activities to the local community, not just to members of the university community.
- Campuses should sponsor workshops for students and perhaps faculty on grant and proposal writing in the field so that they may learn to better communicate and explain their work.

For The Reinvention Center

- The Reinvention Center should work with faculty in the arts to develop strategies for educating committees that award research grant about what research is in the arts and why it is important, and it should take the lead in implementing these strategies.
- The Reinvention Center should invite officials from organizations that fund the arts to its next conference and to other forums, as may be appropriate.

Resources/References

Websites

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2. The University of California at Irvine's Undergraduate Research Opportunity Program: http://www.urop.uci.edu/
3. The University of California, Irvine's Undergraduate Research Journal: http://www.urop.uci.edu/journal.html
4. The University of California, Irvine Undergraduate Research Symposium: http://www.urop.uci.edu/symposium.html
5. The Colorado Council on the Arts and the University of Massachusetts Arts Extension Service have created an online grant-writing workshop. http://www.coloarts.state.co.us/onlinewkhsp.asp
6. The University of Michigan's Arts at Michigan program provides funds for undergraduate student projects, performances, productions, workshops, etc. The program also supports faculty who incorporate arts-based learning into an undergraduate course. http://www.arts.umich.edu/funding/index.html

7. The University of Michigan's First-Year Seminars includes courses in the Arts. http://www.lsa.umich.edu/lsa/facultystaff/lsa_ug_education/curricularprog/fys/
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Breakout Session: Bringing Research to the Classroom within Engineering and Computer Science

Leader: Joseph McCarthy, Associate Professor of Chemical and Petroleum Engineering, University of Pittsburgh
Recorder: Naomi Frandsen, Graduate Student, Department of English, Georgetown University

Presentation

In opening the session, session leader McCarthy, put the discussion in context through a short introduction to some of his philosophy and curricular work. Professor McCarthy is director of an NSF-funded project, "Pillars of Chemical Engineering," a curricular initiative designed to improve chemical engineering education. His goal in undertaking this project was to redesign the curriculum to give greater emphasis to active learning without sacrificing content and to build in experiences that would give students insights into the way systems work, whether the systems involve automobile engines, cell phones, new polymers of computer hardware/software. He began with the assumption that perhaps the most effective way to promote inquiry and discovery is through truly novel discovery, i.e. undergraduate participation in research. In planning this and similar curricular initiatives, Professor McCarthy stressed the importance of defining both the programmatic goals, as well as the goals and desired benefits for undergraduates, at the outset.

In translating this philosophy to the generic issue of including research in the undergraduate curriculum, programmatic goals might include (1) Graduate recruitment; (2) Enhancing the diversity of future graduate classes by introducing more students to research earlier in their educations; and (3) Improving teaching and learning by increasing access for more students to the best scholars. There is some evidence in literature from various sources supporting the success of each of these programmatic goals. In the area of graduate recruitment, increasing the total number of students that continue to graduate school has been shown as an outcome of undergraduate research in studies at both the University of Nebraska and the University of Delaware. Enhancing the diversity of graduate school participants has been a realized goal via the work of the University of Puerto Rico's undergraduate research program. Improving teaching and learning through research has been suggested by the Boyer Report and directly assessed at the University of Delaware.

In incorporating research components into the curriculum and classroom activities, faculty and administrators face both opportunities and hurdles. The hurdles include: The need to modify teaching loads to accommodate the extra time the research component may require, balancing cost/benefit trade-offs of different curricular and pedagogical approaches, assessing student learning, disseminating effective practices, and satisfying requirements for multidisciplinary curricula, which can be implemented poorly. On the other hand, there are several enablers of including undergraduate research in the curriculum, including advances in technology-enhanced instruction, the availability of campus sponsorship through NSF-REU and similar programs, the increasing diversity of the graduate student population, and a number of multidisciplinary initiatives in engineering schools across the country.

Discussion

The discussion began with a survey of session participants' interests and biases with respect to the undergraduate curriculum in engineering and the value in including research-related experiences. The group undertook an in-depth discussion of the various goals of incorporating undergraduate research experiences into the curriculum, as outlined in the introduction. There was a general belief that the main goal should not be to recruit graduate students because that would motivate professors to cater to certain students and leave others behind. Also, an undergraduate research experience only gives students an advantage in the first few months of graduate school. Ultimately, the goals for providing undergraduate research experiences are expected to be different for different constituents: Administrators, for example, often want to improve the quality of teaching; donors want to increase the graduate pool.

It was agreed that the overall goal should be to improve teaching and help build informed citizens who have skeptical minds and are capable of analyzing assumptions and determining relevance. This goal resembles education in rhetoric in which the ability to think critically is built into the curriculum through exercises such as doing literature reviews and through interactions with faculty mentors who introduce students to "the life of the mind." Such teaching should begin in the freshman courses and should stimulate the development of critical thinking skills as well as enable students to understand the complexities surrounding a subject (e.g., ethical issues). Including research in the undergraduate engineering curriculum would be an efficient method of achieving this goal. In an effort to promote this kind of learning, the NSF now requires proposals to include components that speak to the social impact, legal implication, and ethical dimensions of proposed work.

The discussion turned to the nature of undergraduate research. A number of activities that build research skills and that lead to productive research were mentioned, including experienced- and problem-based exercises, case studies, open-ended problems, service learning, co-op/internships, capstone design projects and honors/senior thesis. While a class does not have to include all of these activities to offer successful research-related experiences, all of these approaches have been used with success: ABET strongly supports capstone design; the impact of experience and problem-based learning has been proved in an increasing number of technology-enhanced classrooms, such as those at Pittsburgh, Harvard, and RPI; service learning groups, like Engineers Without Borders, are growing steadily; project or case-study-based courses, such as the industrially-linked course at Purdue, have generated considerable interest. The essential point of all of these activities is that inquiry and discovery are at the core. It was suggested that structuring a curriculum around a hierarchy of experiences can accommodate the different developmental stages of students learning, with, for example, open-ended inquiry working for freshmen and the level of student involvement growing as students mature. The desired outcomes and effects of hierarchical research experiences are the opportunities to benefit from mentoring, open-ended inquiry, networking, immersion, and multidisciplinary approaches to learning.

During this portion of the discussion, session participants highlighted several methods of implementing research-related experiences in classrooms. Concerns over the scalability of bringing 100 students into a lab generated several suggestions. One was to offer a series of classes

that would produce an archive of papers from students in past classes. Another was to bring back alumni who have taken the same class to act as informal mentors. A third suggestion was to introduce research in a capstone class, though many felt it could be introduced earlier. Other ideas that were put forward include finding new sites for encouraging a research culture, such as informal gatherings and social satellite centers, and organizing residence halls by discipline. A hurdle to undergraduate participation in research is student concern about their GPAs and the fear that engaging fully and creatively in research will divert them from their coursework. MIT addresses this fear by using a pass/fail system to grade students in their first year.

A possible danger identified when incorporating research activities into the classroom and creating mentoring relationships between professors and students lies in the personality-intensive nature of labs. Many labs are personality driven, meaning that a professor gathers a team of graduate and undergraduate students and together with them pursues his or her research agenda. This can sometimes lead to a less diverse educational experience as students tend to simply adopt the cognitive patterns of their professor and mentor. Although the lab system is the best way to mentor and teach, further discussion should be aimed at generating ideas on how to avoid this situation.

Another concern raised was the need to provide both incentives and resources to individual faculty members working with undergraduates. Related to this is the difficulty engineering faculty have in balancing their time, given the demands imposed by their research activities and their work with graduate students. These demands often leave them little time to engage in intensive research activities with undergraduates.

Two final concerns were the high attrition rate among prospective engineering majors and the panoply of gender and minority issues in the stereotypically male engineering discipline. Large core classes were blamed for a significant number of student dropouts. Although involvement in research would help students get a sense of what engineering entails and might help lower the attrition rate, the problem of scalability remains. Also, it was believed that including research in engineering education could aid students in finding successful role models with whom (underrepresented) students can identify. It was also suggested that other ways to make the teaching of computer programming (and engineering, etc.) non-gender-specific are needed.

Ultimately, it was agreed that the value of an undergraduate research experience depends to a great extent on the nature and quality of the mentoring the undergraduate receives. The essential elements of mentoring were thought to include a close one-to-one experience working with a faculty member who provides guidance based on his or her own knowledge and experience, as well as intergenerational networking among graduate students, seniors, and freshmen in the same laboratory or research setting.

Recommendations

- Faculty and administrators should model their teaching on engineering design and process. They should first identify performance objectives, specifically the subject matter and technical and cognitive skills, that they would like students to gain (i.e. critical and analytic skills, written and oral communication skills, skills in reading and interpretation). Then curriculum designers should select those activities that best promise to lead students to achieve these objectives. Every institution will have different approaches and strategies in choosing and implementing the activities that best foster achievement of their desired outcomes. They will also have their own methods for measuring the effectiveness of their various efforts. While methods of assessment need to satisfy the ABET requirement for programs to clearly articulate their objectives, there is sufficient flexibility for programs to build in multidisciplinary and cross-disciplinary objectives.
- Departments and institutions should recognize that different research activities will lead to different outcomes. Research should not be theorized as a one-size-fits-all experience.
- Research activities should be designed according to the developmental stages of the students. They should emphasize open-ended inquiry in the beginning years and lead progressively to large-scale service learning or capstone projects in the last two years.
- Engineering departments and schools should collaborate with other units of the university to develop methods to encourage cooperation among faculty, including cooperation across units. One approach is to establish a venue for tracking the experiences of individual faculty.
- Campuses should develop ways to publicize their small-scale, local successes in pedagogy, mentoring and promoting undergraduate research, both within the university community and to other institutions.

Resources/References

Websites

1. A number of the examples in the literature of successfully achieved goals of incorporating research can be found in the ASEE's *Journal of Engineering Education: Colucci-Rios (2001)*, Zydney (2002), Gates (1999), Morley (1998), Narayanan (1999). http://www.asee.org/about/publications/jee/index.cfm
2. The Pillars of Chemical Engineering: A Block Scheduled Engineering Curriculum project was implemented to reform the undergraduate Chemical Engineering curriculum into a series of six pillar courses. http://granular.che.pitt.edu/curriculum/
3. The Undergraduate Research Program at the University of Delaware offers students apprenticeships with faculty mentors and gives them a chance to see and take part in what is happening on the front lines of discovery at UD. Every UD college, department and research center provides opportunities for interested students to get their hands on the source of learning. http://www.urp.udel.edu/
4. The National Science Foundation-Research Experience for Undergraduates program (NSF-REU) provides opportunities for students interested in research projects and for faculty interested in obtaining support for undergraduate research students through either an REU Supplement or REU Site proposal. http://www.nsf.gov/home/crssprgm/reu/start.htm
5. The Massachusetts Institute of Technology report "Freshman Pass/No record Grading and Advanced Placement Policy" is available at http://web.mit.edu/committees/cup/subcommittees/pnrap/part1.pdf. For the student response to this report see http://web.mit.edu/ua/oldwww/2000-2002/PNRAP.pdf
6. ABET, Inc., is the recognized accreditor for college and university programs in applied science, computing, engineering, and technology. http://www.abet.org/home.html

Breakout Session: Bringing Research to the Classrom within Experimental and Data-Intensive Social Sciences

Session Leaders: William Frawley, Professor of Anthropology and Psychology and Dean of the Columbian College of Arts and Sciences, and Elliot Hirshman, Professor and Chair of Psychology, The George

Washington University
Recorder: Pamela Blumenthal, Graduate Student, Department of Psychology, The George Washington University

Presentation

The session was structured around five aspects of integrating research into the classroom:

- Venues: Strategies and approaches that may be effective in different educational settings
- Moving from folk to scientific view of data
- The use of data sets, relations and types
- Doing v. appreciating
- Assessing the experiences

The goals were to brainstorm about these issues, share effective practices and address common concerns and challenges.

Discussion

Using these five aspects as a starting point, the group discussed five issues:

- Determining the value to students of incorporating research into education, both within and outside the classroom.
- Exploring the continuum of research experiences one can make available to students, given the range of student skills and interests typically found, especially in lower level courses.
- Addressing student expectations and student diversity.
- Using a collaborative model in the classroom as a method of integrating research processes.
- Assessing the value of teaching research methods.

Value of Incorporating Research

Exposing students to good social science research and incorporating research and research-related experiences into one's teaching enhances student learning in many important ways. One of the most important is that it teaches them about uncertainty and the value in questioning and casting doubt and how to get closer to the truth through that doubt. In addition, students gain understanding and respect for the process of data-driven investigation and the way data can be used to inform decision making, particularly when it relates to social issues. This understanding is important whether or not students choose to "dirty their hands" and pursue research themselves or instead merely see and read about what other people do.

Regardless of discipline, "research" is the systematic investigation of a problem. Within the social sciences, it involves the collection, analysis and interpretation of quantitative and qualitative data for the purpose of gaining new knowledge about the problem at hand. Within the humanities, the "data" may come from details or other evidence within texts and other materials. Although the disciplinary contexts, data, and methods may differ, all research shares two elements: The systematic gathering of information and the goal of producing new knowledge. Thus "research" may be brought into a class on Great Brooks as well as a social science class. At its best, the research process provides a way of thinking about the world in a particular sphere, a framing in which to view the world.

Students are often resistant to learning about research methods and statistics. The challenge for the instructor is to engage them, to enable them to connect their classroom instruction in methods and statistics to what matters to them. In a statistics class, for example, one can ask students what questions they would like to be able to answer and then teach them a scientific approach to answering those questions.

Instructors need to address several questions in determining how best to integrate research into the classroom:

- Since much classroom teaching is contextual, how does one balance teaching concepts with demonstrating application of those concepts? The group agreed that seeing examples of application and applying concepts themselves reinforced student understanding and enhanced learning.
- Although students take research methods classes, they still may not know how to frame a research question. How does one teach students how to think more skeptically, how to think differently? There was a consensus that this issue needs to be addressed repeatedly, both at the curricular level and at the individual level in the classroom.

Folk data provides psychology and other social sciences with a unique opportunity to teach students about the scientific process because it enables them to gather data from their own observations or experiences and through systematic study determine whether prior beliefs are supported by evidence. Will the data confirm what they have regarded as obvious? Folk concepts provide a good starting point for teaching students not to always trust what they know. It also provides a bridge for connecting personal knowledge to existing theories, which can enable students to better understand the theories. One can ask: What distinguishes theories from folk information? How were the theories developed and tested? Such questions can be useful mechanisms for drawing students into research and explaining the research process.

Continuum of Research Experiences

There is a continuum of "research" experiences that students may have. While all undergraduates should be exposed in the classroom to experiences that require them to grapple with concepts and have the rudiments of the research process, not all students will have the skills or interest for an in-depth research experience intended to produce publishable material. Students range along a ladder in terms of these dimensions, with those at the top ready and often eager to participate in a laboratory experience. The question is how to provide those who are not at the top with experiences that introduce them to the research process and teach them how to frame research questions and learn to think about data. For some students, an instructor's providing facts is enough. Other students want to understand "how." For a small number, those at the top, a light bulb will go off. Professors need to cast a wide net-- knowing that for many students less is enough, but nevertheless trying to urge them to the next level, stimulating further interest among those in the "want to know how" group, and creating real opportunities for the small percentage for whom the light goes off.

How do institutions and instructors meet the needs of these diverse groups? There was agreement that infusing research into the curriculum means more than offering a standard "methods" course and providing laboratory experiences to some students. It also requires incorporating research-related experiences into the curriculum and adopting pedagogical models that emphasize inquiry and problem solving. For example, classroom projects can be structured with a beginning, middle, and end, and involve defining a problem, collecting and analyzing data to address it, and generating findings that contribute to its resolution. One value in teaching students through such methods is that it enables them to learn that research is a continuing process in which one is continually comparing what one currently understands with new information and making adjustments to thoughts and theories.

The availability of resources is critical to the laboratory and classroom experience an instructor can offer because it determines what the instructor is able to do and the number of students that can be accommodated. Resources are made available through the department or the university administration. Since most universities cannot provide laboratory experiences to all students, students have different opportunities, depending on their major.

Several concerns were raised. One is the lack of consistency in what students learn about research questions, methods and processes across programs and disciplines. Students have different experiences and receive different information in many classes and disciplines. If they are unable to integrate the inconsistencies, they will "shut down," withdrawing from research classes and experiences. Greater cohesiveness is needed among faculty, and perhaps within the university. A related issue is that faculty do not receive formal training in pedagogy, and institutions do not provide support for classroom activities that promote, research-based activities. Instructors therefore are sometimes limited in what they can offer to meet students' needs.

Teaching a Diverse Undergraduate Population

For many students, their courses are no more than a series of power-point presentations in which facts are transformed into "bullets" which they are expected to memorize and recall during multiple choice exams. These students are not interested in being involved in research, nor even aware of what it entails or how it might enhance their education. It is the instructor's role to expand their knowledge and understanding, to guide them, and facilitate their understanding of these benefits.

Undergraduates have a range of abilities. They arrive at the university with different academic backgrounds, including different cognitive abilities and quantitative skills and experiences. They also bring important cultural differences to their studies. Some students come already energized, intrinsically motivated, and with little push ready to "take off." Other students are less motivated. Their diversity of backgrounds and expectations may separate students and deter them from helping others. For students who are already challenged, this environment imposes even greater difficulty.

The diversity among students poses great challenges for faculty. To participate meaningfully in research, students need to be able to think, write, and have abstract analytical abilities. They may also need understanding of quantitative concepts and techniques. Without fundamental knowledge of statistics and mathematics or an ability to think abstractly, students may not benefit from a research methods class or other courses with a quantitative orientation. An early exposure to research, particularly in their introductory and foundation courses, may stimulate them to take courses that will enable them to develop these skills.

A question was raised as to whether faculty make too much of the diversity of student perspectives. Does integrating research in the undergraduate curriculum require consideration of individual perspectives? There was a consensus that instructors must consider the individual differences of their students, while acknowledging that many teaching environments make that difficult and prevent intervention. If professors are motivated to move everyone forward, to push their students up the ladder, they need to understand where students are coming from to balance the students' needs with their own aspirations and expectations for the students.

Diversity is particularly important when teaching students about the mode of thought that drives research since developing a researcher's frame of mind requires, in part, understanding the limits of what we know. Examining a subject from multiple perspectives can help students to gain such understanding. Nevertheless, many institutions and faculty do not consider student diversity. A continuing issue for the Reinvention Center should be to foster discussion on ways to take advantage of students' diversity so that it becomes a valuable teaching tool.

A Collaborative Model

The range of abilities, interests and experiences that exists among students may make it difficult to integrate research into the classroom. One method that many instructors use to address this challenge is to give assignments that require group work. This method has been used effectively in large lecture classes, as well as in small seminars. Its proponents like it because it enables students to engage in the kind of collaborative process that is often integral to the research environment. It also provides an opportunity for peer learning among diverse groups. At the same time, giving group assignments presents several challenges that range from the group finding a time to meet, particularly when members are commuting/working, to creating groups within large class settings, to grading student effort and group products.

Some instructors experienced in group-work suggested that students not be graded for a group product. They recommended instead that assignments be designed so that the group members select a topic and collect data together but write individual papers, which are the only graded product. Other instructors indicated that a small percentage of the grade, perhaps 10%, be based on the group product or on evaluations provided by the group. Other session participants argued that one of the goals of a group assignment is to teach students to work with other people and to find a way to share responsibilities to accomplish a goal. Many outcomes that researchers experience are based not on individual activities, but on group or organizational accomplishments. The group product, they maintained, needs to include an outcome component that affects the students' grades.

Questions raised include: What do students learn by working in groups? Does group work effectively address issues of student diversity, allowing them to draw on one another's strengths to learn to think critically? Alternatively, are students focused only on the grades and the final product? Is it important to teach the students how to address problems as a group (by having the outcome related to the group product) or should instructors maintain an individualistic approach, using the group structure, but having students focus on their individual products? Is one of the unmet goals of education teaching students how to work and interact with other people?

Assessment

How can universities determine the extent to which programs and courses with a research emphasis are effective in achieving their goals and desired outcomes for students? Although few universities systematically collect data that would yield the answer to this question, universities have information, including anecdotal evidence, that they can use as a guide.

The effectiveness of university efforts may depend on several factors, including the size of the undergraduate population, the number of students typically enrolled in introductory and foundation courses, and the presence of a supportive infrastructure. Several members of the group teach classes ranging from 150-300 students; these numbers make integration of research more difficult without institutional support. Session leader Frawley suggested that managerial changes often need to occur to allow greater integration of students in research, given these numbers.

At Carnegie Mellon, one-third of the undergraduates participate in research activities, which may include attending research meetings or co-publishing with faculty. When Carnegie Mellon conducted an informal survey of alumnae in which they were asked to name the undergraduate classes that they have found to be most useful, research methods, statistics, and computer classes emerged at the top of the list. This finding affirms of the value of research-intensive undergraduate training. Surveys of alumnae similar to the one conducted by Carnegie Mellon offers graduates a good way to reflect upon their educational experience and gain knowledge of the long-term benefits graduate derive from various courses and programs.

The University of Connecticut conducts polls of graduating seniors in which they are asked to recall information they think they have retained from a range of classes. Psychology students typically refer to materials from their research methods class.

Does evidence exist to show that research experiences (in and out of the classroom) benefit students in subsequent courses. Is the knowledge they gain portable? One member of the group reported that collaborative work that had been integrated into a 300-level class had been identified by the professor of a 400-level class as resulting in improved student performance. The students who had worked in groups were better able to think critically and grasp concepts. The group agreed that assessment is an important element as universities try to better integrate research into the classroom.

Recommendations

- Faculty should increase their use of group assignments and other collaborative learning models in order to address the educational needs of the diverse population in research methods and associated courses and enhance learning among all students.
- Departments should provide a range of research experiences from exposure to research experiences in introductory and foundations classrooms to laboratory participation to apprenticeship models and student-initiated research to meet the needs and interests of students of varying backgrounds and levels of motivation.
- Faculty, departments or a centralized office should perform post-test assessments to compare pedagogical innovations to standard methods to determine the educational value of these innovations.

Resources/References

Websites

1. The George Washington University Undergraduate Research Website promotes undergraduate student research and scholarship: http://www.gwu.edu/~research/undergraduateresearch/
2. The Undergraduate Research Office at Carnegie Mellon University recognizes and supports undergraduate research: http://www.cmu.edu/uro/
3. The Undergraduate Research Office at the University of Connecticut provides a broad range of enrichment activities to promote research and creative activity: http://ugradresearch.uconn.edu/

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Frawley_Hirshman/Powerpoint.pdf

Breakout Session: Bringing Research to the Classroom within the Humanities and Discursive Social Sciences

Leaders: Gerald Graff, Professor of English and Education, and Cathy Birkenstein-Graff, Instructor in English, University of Illinois at Chicago
Recorder: Steve Benton, Graduate Student, Department of English, University of Illinois at Chicago

Presentation

Session leaders Gerald Graff and Cathy-Birkenstien Graff began their presentation by distributing a handout on "The Form that Research Takes," which included the following four research proposals modeled on proposals Gerald Graff had been asked to judge when he helped run the annual undergraduate research conference at the University of Illinois at Chicago.

A. The Dating of the Homeric Epic. Some scholars have tried to date Homer to the eighth century by pointing to Late Geometric vases that, they believe, contain images derived from the text of Homer's Iliad. By examining this Geometric art, I intend to show that the scenes cannot represent episodes from the Iliad.
B. Renal Interstitial Hydrostatic Pressure (RIPH) and Pregnancy. The objective of this study was to test the hypothesis that a decrease in renal interstitial hydrostatic pressure (RIPH) accounts for the blunted pressure natriureses during pregnancy.
C. Why do Some Criminals Become Repeat Offenders? Many hard-line conservatives want to simply imprison criminal offenders and throw away the key. By analyzing the histories of repeat and non-repeat offenders, however, I will offer several alternatives to this harsh policy and suggest ways to minimize criminals' high-recidivism rates.
D. The History of Belize. In this project I explore the conflicts over race, ethnicity, and gender in the Central American nation of Belize.

As session participants were reading the proposals, they were encouraged to consider such questions as: How do you know good research when you see it? and How do you play the "game" of research? After they had been given a chance to look over the various proposals, they were asked to vote on which ones they considered the best of the group and which they considered to be the worst. The vote revealed significant differences of opinion among the group and a lively debate ensued.

One issue of contention turned on the question of whether "openness to exploration" should be valued over "contextualization." Thus, for example, some participants criticized proposal C, "Why do Some Criminals Become Repeat Offenders?" because "it comes with a presupposition of the answer," while others praised it, because, like proposal A, "The Dating of the Homeric Epic," it challenges an established paradigm. This debate led to discussion of whether the judging criteria for research proposals transcended disciplinary norms and whether, for example, some disciplines tend to have a more antagonistic attitude towards prior research. Some argued, for example, that while research among classicists often sets out "to prove other people wrong" or to challenge an existing paradigm, this is less true of research in the sciences. There was further debate about whether "proving other people wrong" should count as making an original contribution.

After each of these controversial issues had been flushed into the open, Graff and Birkenstein-Graff made their own case for judging the quality of the proposals based on whether they map their claims relative to the claims or hypotheses of others. As Graff and Birkenstein-Graff argued, this question of relevance must be addressed, whether the research is exploratory or disputative, since "Even if you don't know yet what your argument is going to be, you will want to start out by knowing what other folks are saying. You can be exploratory and open-ended without

confusing readers." When you map your claims relative to the claims of others, you indicate your motivation and address the fundamental questions of why your research is important and why other people should care about it. The best researchers realize that learning how to play the "game" of research is a matter of learning how to think of research as a way of entering a conversation. If researchers do not indicate the conversation they are entering, other researchers will not have a way of understanding what they are saying.

It is crucial to get this point across to undergraduates and their teachers because an overwhelming number of undergraduates think of research as a monological enterprise. Though in the real world, effective research does not just make a claim in a vacuum, undergraduates tend to think of research as stating factual information in a vacuum, "telling us what they know" without providing a frame for that knowledge. Asking students to "enter the conversation" and actually getting them to think and write about their research in this way, Graff and Birkenstein-Graff have found, is not easy. One strategy that they have tried successfully in their own classes in getting students to learn the "research game" is to provide them with writing templates that draw attention to some of the key moves made by effective researchers.

The most fundamental template which is indicated in a phrase like "Many have long believed 'x,' but I want to claim 'y'"—is something Graff and Birkenstein-Graff refer to as the "They say/I say" template, which encourages researchers to preface their own claims with references to the conversation they are entering. Graff and Birkenstein-Graff distributed a more elaborate version of this template, taken from their forthcoming book, *They Say/I Say: The Basic Moves of Argumentative Writing* (W.W. Norton, 2005). The template reads:

"In recent scholarly discussions of _____, a controversial issue has been whether _____. On the one hand, some researchers argue that _____. As _____, a prominent proponent of this view, puts it, "_____." On the other hand, other researchers reply _____. According to this view, _____. In sum, then, while some researchers argue _____, others argue _____. My own research leads me to favor _____. While my research does suggest that _____, it conclusively shows that, overall, _____. In conducting this research, I _____. What I basically set up was a _____. Early findings suggest that _____--in effect, that _____. Of course it might be objected that _____. While it is no doubt true that _____, our research does show that _____. In sum, then, it appears that _____--an important point to make because _____."

While Graff and Birkenstein-Graff acknowledged the fear that many people have that such templates will stifle intellectual creativity, they insisted that all creativity depends to some degree on preexisting formulas and established genres, if only to play off of them. Though there is a tendency to think of set forms as strait jackets, an entirely original utterance, composed of words which have never before been used, would be non-sensible (a point which Graff illustrated by producing an entirely original string of incomprehensible gobbledy-gook).

One way teachers can use these templates is by encouraging students to try them in their writing. Another way is to help students recognize that published authors employ similar templates in their own writing. Graff and Birkenstein-Graff have designed classroom "games" they call "Dialogize This" and "Spot the They Say" which encourage students to identify the conversation which a given text is entering. Such games, in which students look for the controversial elements in a text, challenge many students' perception that academic work is "unproblematic stuff that you memorize and give back." George Chauncey's *Gay New York: Gender, Urban Culture, and the Making of the Gay Male World, 1890-1940* provides an example of such problematizing "They Say/I Say" research/scholarship:

> "The periodization I propose here is counterintuitive, for despite the cautionary work of historians such as John D'Emilio, Allan Berube, and Lillian Faderman, and the events of recent memory (such as the anti-gay backlash that began in the late 1970s and intensified in the wake of AIDS), the Whiggish notion that change is always 'progressive' and that gay history in particular consists of a steady movement toward freedom continues to have appeal. This book argues instead that gay life in New York was *less* tolerated, *less* visible to outsiders, and *more* rigidly segregated in the second half of the century than the first, and that the very severity of the postwar reaction has tended to blind us to the relative tolerance of the prewar years."

Graff and Birkenstein-Graff have found that showing undergraduates examples like this, of a successful research project, plays off the fundamental "They Say/I Say" template and can help them plan and later present their own research in a way that underlines, rather than, suppresses its controversial and "conversational" elements.

Discussion

In the group discussion of Graff and Birkenstein-Graff's proposals, one of the session participants suggested that different disciplines may attribute lesser importance to the necessity of providing a frame for their research than perhaps literary scholars. Chemists might be so "in the game," for instance, that they might see the conversation the new research is entering without needing to have it spelled out for them. Graff and Birkenstein-Graff acknowledged that the conventions of how the conversation is entered may be very different in different disciplines, but insisted that the need to provide a contextual frame transcends the disciplines. As Birkenstein-Graff put it, "Even if you are writing for other researchers in your own field, you still have to remind them of what they know." Consequently, whether the research is being presented to a general audience or an audience of specialists, it is useful to couch it in terms such as "Many have long believed 'x,' but I want to claim 'y.'" "You have to sketch in the motivating conversation," Graff added, "whatever language you express it in. You have to sell why it matters. We're not talking about intelligibility, we're talking about stakes—[and those stakes] depend on pre-established structures outside of what you are saying." Different disciplines have different ways of indicating those stakes, but these differences have too often obscured some fundamental commonalities.

Another session participant confirmed Graff and Birkenstein-Graff's contention that such framing devices are important to research in the sciences, as well—assuming the researcher hopes to disseminate his or her findings. The view that there are "basic requisites for research that go across the disciplines" was seconded by a second participant, a biologist, who affirmed that research in the sciences must also "talk about motivation, why [the research] is important, what is known about it . . . [and] what do I think about it—what do I expect, and what are the methods I am going to use to verify or falsify" my claims.

The political implications of the "They Say/I Say" template's emphasis on prior conversations was a point of concern for another participant who wondered if such an approach might discourage engagement with the "voiceless." In other words, would not such an approach tend to legitimate traditional ways of looking at problems? As this questioner put it, "If you are actually working with communities that haven't had a voice, you don't want to make them go through what everybody else has said before you give them an opportunity to make their point. It sounds to me like you're describing a traditional mode of scholarship

that may not be the best way to value the contributions of marginalized communities . . . If you could only move forward by assimilating the mainstream dominant discourse . . . [wouldn't that] sanitize radical discourse?" Graff and Birkenstein-Graff responded that radical critiques of traditional ways of looking at problems are not exempt from the need to frame their critiques in a way that makes them clear to their readers. Disempowered groups also need to learn how to use a "they say/I say" template in order to critique the status quo. "Even if you want to displace the current conversation," Birkenstein-Graff argued, "you have to *mention* the current conversation." One template which might prove useful to "voiceless" or marginalized groups who want to challenge conventional analyses, Birkenstein-Graff suggested, might include a phrase like this one: "Most people are so busy talking about 'x,' that they don't notice the problem of 'y.'" Graff and Birkenstein-Graff maintained that teaching students to use such templates is less a matter of forcing them into a rigid, pre-existing structure than it is a matter of demystifying, and democratizing the world of research. "Where you would say 'rigid,'" Graff summed up, "we would say 'clear.'"

Recommendations

The use of some fundamental writing templates—such as "While may think X, I argue Y"—can help humanities, social sciences and science departments teach undergraduate students how to think and write about their research in a way that clarifies its relationship to existing conversations within the discipline, between differing disciplines, or in the general public (as opposed to conceiving of and presenting the research as "true statements" in a vacuum).

Educators should take a proactive approach to teaching students the "basic moves of research. "Don't wait for students to pick them up." One way teachers in any discipline can do this is by calling attention to the conversational element of research work by foregrounding the "dialogical moments" in the texts studied in class. Another way is to find ways to integrate the principals of "They Say/I Say" dialogism into writing assignments (see above). In either case, presenting students with intellectual controversies rather than strongly advocating particular views is a good way for teachers to gives students an "in" to the research game.

Campus-wide workshops on how to do research can be a good way to raise awareness of the conversational elements in research in all the disciplines. As an added benefit, such workshops can also help create interdisciplinary conversations about what constitutes successful research and reward research work which bridges disciplines.

Resources/References

Publications

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2. Graff, G. (1970). *Poetic Statement and Critical Dogma*. Evanston: Northwestern University Press.
3. Graff, G. (1979). *Literature Against Itself: Literary Ideas in Modern Society.* Chicago: University of Chicago Press.
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5. Graff, G. and Warner, M. (Eds.) (1989). *The Origins of Literary Study in America*. New York: Routledge.
6. Graff, G. (1992). *Beyond the Culture Wars; How Teaching the Conflicts Can Revitalize American Education.* New York: W.W. Norton.
7. Graff, G. (2003). *Clueless in Academe: How Schooling Obscures the Life of the Mind.* New Haven: Yale University Press.
8. Graff, G. and Birkenstein-Graff, C. (Forthcoming). *They Say/I Say: The Basic Moves of Argumentative Writing.* New York: W.W. Norton.

Breakout Session: Bringing Research to the Classroom within the Life Sciences and Related Areas within Psychology

Leader: Sarah C.R. Elgin, Professor of Biology, Washington University at St. Louis
Recorder: April B. Bednarski, Curriculum Specialist/ Instructor in Biology, Washington University at St. Louis

Presentation

There is a range of models that instructors can adopt in their efforts to bring research into the classroom. If one thinks of this range in terms of a spectrum, lecture-only courses are at one end and summer research experiences are at the other end, with other approaches fitting in between these two extremes. The model an instructor may choose depends on the particular class situation (i.e. introductory v. upper level), the number and level of students to be taught, the extent of research engagement they want to provide, and the availability of required resources.

Six models, each positioned at a different point in the spectrum, were presented.

- A research-based course for upper level students offered at Washington University in St. Louis and presented by Dr. Sarah C.R. Elgin, Professor of Biology, Genetics, and Education. This first model is close to the summer research experience on the spectrum since students work to generate and analyze original data so that it is of publishable quality. The course starts out at WU's Genome Sequencing Center where a group of 10-12 students work together to sequence a novel segment of a genome. Once this sequence is obtained, still working as a group, they spend the rest of course time assembling and annotating this segment and then preparing and presenting a final report. The course is interdisciplinary and his team-taught by genome sequencing specialists and faculty members from the departments of genetics, computer science and biology. This model requires significant resources; $20,000 in sequencing fees per semester and laptop computers for each student. Computer-based ways to network the course are being explored, with the goal of providing a research experience in genomics to undergraduate students at other institutions. http://www.nslc.wustl.edu/courses/Bio4342/bio4342.html

- The Graduate Research Consultants (GRC) program offered at the University of North Carolina at Chapel Hill and presented by Dr. Patricia Pukkila, Associate Professor of Biology and Director of the Office of Undergraduate Research. This recently-developed initiative is designed to extend the benefits of a research university to undergraduates college-wide. The GRC program provides faculty members with a structure and resources, in the form of graduate student "research consultants," to integrate undergraduate research projects into their lecture courses. The specific nature and scope of the research projects is determined by the faculty member teaching the course. The GRC's role is to guide 5-20 undergraduates within the lecture course as they undertake an individual or small group research project. The GRC meets with the undergraduates to help them determine if their research topic is appropriate and feasible, and provides advice on how to follow through with the work to create a finished product. The GRCs work for 30 hours during the course of a semester and are paid $500.

Since the time commitment is small, the GRCs are still able to devote most of their time to their own research. The GRC program is being used primarily in social science courses, but has the potential to expand to other disciplines across campus. A major strength of the GRC program is its inherent flexibility; the program can be adjusted according to class size, budget, discipline, and the needs of the instructor. Assessment of the program thus far has shown that the graduate students find it to be a transformative experience, while undergraduates enjoy the experience enough to seek out similar opportunities and recommend the program to other students. http://www.unc.edu/depts/our/GRCprogram.html

- A computer-based research lab that accompanies a large introductory course offered at Washington University and presented by Dr. April Bednarski, Department of Biology. This lab was developed to provide an investigatory experience within a lecture course, to create a format for group work, and to introduce students to web-based bioinformatics tools and databases. Students collaborate with partners to investigate a protein with a single amino acid mutation. They start their investigations with a cDNA sequence, then progress through a BLAST search, a crystal structure investigation, and eventually investigate the mutation in the OMIM database. At the end of their investigations, students write and present a report that connects DNA sequence to protein structure, and to phenotype. Students present their reports in small groups, discuss and defend their results, and then complete a joint quiz within the group. This model demonstrates a computer-based research experience that familiarizes students with the tools now available to research scientists. This model works well for a large class with limited time, and requires only computers as a lab resource. http://www.nslc.wustl.edu/courses/Bio3055/bio3055.html

- The Explorations program offered at Cornell University and presented by Dr. Laurel Southard from the Office of Undergraduate Biology. The Explorations program, which is an integral component of the introductory biology course, was developed to introduce potential Biology majors to research in their first year at the university. Biology faculty members make available a certain number of "slots" to undergraduates for short research experiences or "explorations" within their area of specialization. Students are expected to sign up for at least two slots, but they can sign up for additional research experiences if they are available. This program reaches a large number of students early in their studies, is low cost, and is successful in integrating research experiences into a lecture course. Faculty use this program to help identify students to invite back to work in their laboratories. Undergraduates use these experiences to connect with faculty and help define their areas of interest within the biology major. http://instruct1.cit.cornell.edu/courses/biog105/

- Two upper level courses that are part of a "Pre-Grad" program offered at Stanford University and presented by Anna Ballew of the Department of Biological Sciences. The program, lead by Professor Tim Stearns, provides an opportunity for undergraduates to learn more about and prepare for a research career. The first of the courses is a "research" course designed for a small number of students who, first, receive training in using yeast and, then, are challenged to plan and perform their own experiments, analyze the data and present their results. In the second course, the students read and discuss primary literature and attend departmental seminars. The reading is of an article that relates directly to an upcoming seminar. One student is responsible for providing background and introducing the article to the group, while a second leads the critique. This process helps students learn how to give good presentations and how to read and understand primary literature. Students report that they understand 80% of the seminar after going through this process, and estimate that they would understand only 30% of the seminar otherwise. The course helps introduce students to the culture of science, including critical reading of the primary literature, attending seminars, and discussing current research. Information on the courses may be found at: http://pregrad.stanford.edu. For a good resource on online assessments, conference participants may want to check out: http://www.getfast.ca/.

- A format for introducing reading and analysis of primary scientific literature into a large lecture course, offered at the University of Colorado at Boulder and presented by Dr. William Wood, Distinguished Professor of Molecular, Cellular and Developmental Biology. The format entails students' accessing an assigned paper from the course Web site, reading the paper, and, working in teams of 3-4, analyzing and presenting a part of the paper to the class. Student groups, for example, may be given the assignment to explain a figure, a method, or a table. The students will discuss that particular part of the paper and how they plan to present it, and they will then choose a spokesperson from the group. Each group has three minutes in front of the class to give its explanation. The papers are chosen to complement the lecture topics and are usually either a classic paper or a paper describing a method or approach. This format provides a way for students to be active in a large course, begin reading the scientific literature, and see some of the data on which their textbook is based. http://www.colorado.edu/MCDB/MCDB4650_FA04/

Discussion

Incorporating Research into Lecture Courses

The discussion focused on the importance of having models available that incorporate research-oriented activities into teaching, but that do not completely replace the lecture format. Participants recognized that cognitive research shows that students have much shorter attention spans than the length of a typical lecture and that integrating active components into the lectures adds value in many ways. The main challenge to incorporating more research and active learning components into lecture is a possible loss in breadth of content.

It was pointed out that any reduction in content can be especially difficult in fields such as nursing that have very defined content standards. Several possible solutions were discussed. One suggestion was to leave minor, easily understood topics for students to learn on their own and concentrate class time on the most challenging concepts. The "Just in Time Teaching" approach was discussed as a way to tailor lecture time to the concepts students find most difficult (Novak, Gregor M., et al., *Just in Time Teaching: Blending Active Learning with Web Technology*, Prentice Hall, 1999). With this teaching method, reading and problems are assigned before class. Students must submit their answers to the problems before lecture, with enough time allowed for the instructor to look over their answers. The instructor then tailors the class lecture and discussion to cover topics most students struggled with in problem sets.

Participants also were concerned with the range of preparation that students in introductory courses typically have. Some students may be able to learn basic concepts on their own while other students cannot. Peer-learning offers one possible solution to this challenge. Groups of students with a range of skills and preparation discuss difficult concepts, relying on the process of discussion and persuasion to result in deeper understanding. More about peer instruction can be found in Eric Mazur's book, *Peer Instruction: A User's Manual,* Prentice-Hall (1996).

Participants also discussed the desirability of paring down content in introductory courses in order to incorporate research approaches and projects. An important step to achieving this goal is to define a framework of essential concepts. A framework for the life sciences, "The Biology Concept Inventory," was recently developed by Dr. Graham Walker's group at MIT, and published in the Summer 2004 edition of *Cell Biology Education*. This is a freely-accessible online journal at www.cellbioed.org. In addition, participants mentioned the effort by Dr. Michael Klymkowsky at the University of Colorado at Boulder to collect content information about introductory courses in the biological sciences from institutions across the country through his Website www.bioliteracy.net

How to Initiate Change

The general consensus of the group was that change needed to happen incrementally, but that it was important to keep a clear goal in mind. The participants mentioned the importance of communicating successes in bringing research into our classrooms by participating in the education events at national meetings and by publishing education articles in journals like *Cell Biology Education* (www.cellbioed.org) or other discipline-specific education journals. Some scientific research journals (i.e., Genetics) are also beginning to include education articles.

Faculty development workshops were discussed as one method to help bring about change. Two faculty development workshops in biology were mentioned: The National Academies Summer Institute on Undergraduate Education in Biology (http://dels.nas.edu/summerinst/index.shtml) and Faculty Institutes for Reforming Science Teaching (FIRST2), led by Dr. Diane Ebert-May at Michigan State University (www.first2.org).

Overall, participants would like more advice on steps to take to initiate change on their campuses. The following questions were raised.

- What are the steps involved in the process of change?
- How do we convince our colleagues and our deans where change is needed?
- What are some strategies that have worked?
- What does current research say about the process of change?

The group concluded by agreeing on three specific recommendations. Recommendations:

- Organize teaching so that the research thinking process is supported by the group work in the class.
- A wide range of incremental changes can be used to address the first recommendation.
- At future meetings, include discussion of strategies to implement institutional change successfully.

Resources/References

Websites

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2. The Graduate Research Consultants (GRC) program at the University of North Carolina at Chapel Hill. Graduate students guide undergraduates within the lecture course as they undertake an individual or small group research project. http://www.unc.edu/depts/our/GRCprogram.html
3. Studying the Genetic Basis of Disease Using Web-Based Bioinformatics Tools. A computer-based research lab at Washington University in St. Louis developed to provide an investigatory experience within a lecture course, to create a format for group work, and to introduce students to web-based bioinformatics tools and databases. http://www.nslc.wustl.edu/courses/Bio3055/bio3055.html
4. The Exploration Program at Cornell University introduces potential Biology majors to research in their first year. http://instruct1.cit.cornell.edu/courses/biog105/
5. The Pre-Grad program at Stanford University enables undergraduates to learn more about and prepare for a research career. http://pregrad.stanford.edu
6. Free Assessment Summary Tool (FAST) is an anonymous online survey tool that automatically summarizes students' impressions of a course and/or teacher and supplies the data directly to the teacher. http://www.getfast.ca/
7. Offered at the University of Colorado at Boulder, this Developmental Biology course website provides a format for introducing reading and analysis of primary scientific literature into a large lecture course. http://www.colorado.edu/MCDB/MCDB4650_FA04
8. Michael Klymkowsky (University of Colorado at Boulder) has collected content information about introductory courses in the biological sciences. www.bioliteracy.net
9. Faculty development workshops in biology: National Academies Summer Institute on Undergraduate Education in Biology: http://dels.nas.edu/summerinst/index.shtml; and Faculty Institutes for Reforming Science Teaching (FIRST2): www.first2.org
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POWERPOINT PRESENTATION

www.sunysb.edu/Reinventioncenter/Conference_04/Elgin/Presentation.htm

Breakout Session: Bringing Research into the Classroom within the Physical Sciences and Mathematics

Session leader: Robin L. Garrell, Department of Chemistry and Biochemistry, University of California, Los Angeles
Recorder: Heather Shepherd, Department of Chemistry and Biochemistry, University of California, Los Angeles

Research experiences can be integrated into the undergraduate science curriculum in three general ways: Through use of the scientific literature, through guided inquiry-based activities, and through open-ended discovery. The breakout session was structured around these categories of engagement. The scientific literature can be viewed broadly, encompassing the general press (newspapers and magazines), reviews written

for general to expert readers, as well as the primary research literature; all of these are widely accessible through libraries and the internet. Inquiry-based learning encompasses many activities, but is generally centered on open-ended problem solving in a small group or laboratory context. In addition to facilitating mastery of factual knowledge, this approach builds students' reasoning and communication skills. The highest level of undergraduate engagement in research centers on discovery, in which students learn advanced skills and address open-ended questions aimed at designing and testing hypotheses and creating new knowledge, either through experimentation or the synthesis of information from disparate sources. Analysis and communication skills are also developed in the process.

Presentation

The discussion began by enumerating barriers and challenges to providing research experiences to all undergraduates in physical sciences and mathematics courses. Faculty may be overburdened, students unprepared, and mentors in short supply. Research institutions may have additional constraints: too many students to accommodate in limited lab space, as well as tight budget constraints. There are also more general challenges, such as deciding how to engage a diverse student population in which many are interested in science, while others are disinterested, skeptical or fearful. The learning habits and previous educational experiences of many incoming freshman represent an intrinsic barrier to introducing teaching innovations and implementing change. Many new college students are unfamiliar with inquiry- or discovery-based learning, and balk when drawn away from rote-based learning strategies with which they have become comfortable.

Topic 1: Increased Preparedness – Discovery

The discovery process of research can be introduced at all levels of undergraduate education. A lab course in which students develop the skills needed for conducting research in a laboratory setting could be made available to students early in their undergraduate careers. Such a course would develop students' proficiency in basic laboratory, library and communication (particularly written and oral presentation) skills. The goal would be to pre-certify students for laboratory work, make them research ready, and thus decrease the training burden on faculty and lab mentors.

Topic 2: Engaging a Broader Group of Students – Literature

The scientific literature provides a vehicle for exposing students to the latest scientific discoveries and for teaching research methods and content. Engaging all students in research through the literature can begin as early as the freshman year. In large lecture classes, introductory review articles or examples of current research conducted by faculty at the university can easily be incorporated into lectures and discussions. For students already interested in science, as well as those who need some convincing, a simple introduction to current discoveries related to the material covered in class can provide context that will get them engaged with the material. For smaller or more advanced classes, students can write critiques of an assigned literature article, thus learning how to analyze an article, formulate a constructive argument and write an objective narrative. These very simple approaches are ways to introduce research and inquiry-based learning early in students' undergraduate careers without compromising the amount of content covered. The aims can be achieved with minimal time and effort by already overextended faculty.

Topic 3: Classroom as Research Site

A senior level laboratory course can serve as the locus for undergraduate research. The Materials Chemistry laboratory at UCLA is one example. In the first half of the course, students synthesize and characterize polymer, ceramic and inorganic-superconducting materials, learning both synthesis and analytical methods. In the second half of the course, the students use their newly-developed skills and knowledge base to repeat experiments from one of several pre-selected journal articles. Based on their experiences, they develop and refine their own protocol for an experiment to be conducted by the next generation of students. Designed for undergraduates at the end of their career, this course introduces students to current research techniques and concerns not normally covered in introductory lab classes. It also teaches students how to read the literature and translate other investigators' experiences into their own context. Students learn some of the basic (and invaluable) lessons of research, including the fact that that not all experiments work, that not all methods are perfectly described in the literature, that they may need to use additional resources (literature, peers, professors), and that they are empowered to improve upon published work. The course has been an excellent segue for students who then join research labs for senior projects. This type of course can take advantage of whatever instrumentation resources are available at the institution. Faculty benefit from this type of course as well. Essentially, the students are assuming some of the burdens of course development by testing and optimizing the new experiments and helping write them up in ways their peers can understand.

Discussion

Response to Topic 1:

Participants were not uniformly enthusiastic about the benefits of a research skills class. Students may not develop sufficient proficiency in the necessary skills, or may not be exposed to the range of skills needed for specific projects. Other skills are best developed within the context of the research project. Participants with experience offering this type of course found it was too dry, devoid of context, and the skills, once learned, were forgotten before work in a research lab began. These challenges could potentially be overcome by making the lab more context-based and less abstract, while requiring the students to have an apprenticeship by the end of the term.

Response to Topic 2:

Participants from a wide range of disciplines described their considerable experience using literature as a method for incorporating research in the classroom. A particularly successful method is to assign introductory papers in the beginning of the term for students to read and discuss, and then assign papers of increasing difficulty as the term progresses. Students are more engaged with the material, and learn directly about current research in the discipline.

Response to Topic 3:

Inquiry is often a neglected process in undergraduate education. Most students are introduced to experimental science in undergraduate laboratories in which the experiments are planned and the results predetermined. Students learn the basic skills needed to function in a lab, but the thinking process involved in approaching science is not taught. Exercises involving open-ended questions can introduce students to this sort of inquiry. Students, for example, can be presented with a question and asked to determine the answer. Then, working in groups they design experiments to answer the questions posed and identify causal connections. This method draws the students in by giving their work context and meaning, while at the same time teaching them how to pose questions and design experiments to investigate and then solve the mystery.

Throughout the discussion, context-based instruction was reiterated as a powerful tool for drawing disinterested students into the subject and for enlivening dry classes. Introducing "real life" examples into a lab or lecture helps provide a context for the otherwise abstract information.

In a large lecture class, instructors can present examples from the current literature related to the subject being covered. In lab courses, students can perform experiments following a published research protocol. An example of a particularly creative approach is Angelica Stacy's introductory chemistry lab course at the University of California, Berkeley, in which students test water samples from around the city as part of their assignment. Giving the students applications or context for the information they are being taught enlivens the course, introduces inquiry-based learning, and brings "research" to the forefront of the undergraduate education.

Although much of the discussion focused on new ways to present, utilize or conduct research in the undergraduate classroom, participants identified significant barriers to their implementation. The lack of support for professors to learn and implement inquiry-based learning is a barrier that was repeatedly iterated. If the goal is to introduce undergraduates to research, either through literature or hands-on experience, then there must be a support and reward system in place to encourage professors to be more proactive in curriculum development. A strong institutional commitment is then needed that places a higher value on assessing and rewarding quality teaching and educational innovation. The participants were in agreement that it will remain difficult to implement new teaching ideas until these institutional reforms take place.

Recommendations

- Bringing research into the classroom broadens the pool of students who learn the process and impact of scientific discovery. Successful vehicles, many of which are most effective in a small group context include:
  - Discovery-oriented classroom demonstrations.
  - More meaningful lab experiments (e.g. Analyzing water-quality in the Bay area)
  - Reading and critiquing the research literature (from introductory review articles to articles ASAP), to teach the scientific method, critical thinking and technical and general writing.
  - Replicating recent research in undergraduate laboratories
  - Offering research skills courses to prepare students for lab-based research

- Teaching is rocket science. We need to better prepare faculty to use inquiry-based teaching methods and to assess and improve their own teaching effectiveness. Doing so will require a strong institutional commitment (e.g. professional educators to work with faculty), as well as buy-in from the disciplines (e.g. push and pull incentives for faculty participation). Success may hinge on a cultural shift for other administrators and faculty: specifically, placing greater value on high quality teaching and educational innovation and making the assessment of teaching quality and the reward system (tenure merit increases) consistent with that value system. This shift can begin with better TA training (e.g. preparing future faculty) to create a core of new educators who will bring these skills an values forward.

Resources/References

Website

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POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Garrell/Garrell_Powerpoint.pdf

Plenary Session: Incorporating Principles of Learning into Undergraduate Education

Moderator: Ralph W. Kuncl, Professor of Neurobiology and Provost, Bryn Mawr College

This second plenary session is entitled "Incorporating Principles of Learning into Undergraduate Education." The shared goal of everyone in this room is higher-order learning. The question is, how do universities and colleges best achieve that?

This plenary is conceived as a session on translation, from both the theoretical underpinnings of learning and the basic science of learning. We want to explore with you how basic research findings in psychology and biology can impact what goes on in the classroom, the lab, and the studio.

Before we go to the speakers, I've been asked to lay down some contextual background, and I will do this by focusing on national initiatives and federal funding for research on learning.

You can all easily think about hundreds of pedagogical questions to which we don't know the answer: What technique works best for retention of knowledge in my discipline? What is the optimal class size for what I do? How does ethnic diversity enhance learning, and what is the evidence it does? How can basic cognitive science about the laying down of memory traces and synaptic connectivity be translated into the classroom? There are innumerable other such unanswered research questions.

Here is the recent history of some high-impact events in educational research on learning.

In 2000, the National Academy of Science and the National Research Council published a book entitled, *How People Learn: Brain, Mind, Experience, and School* in order to explore just the critical issues we are

talking about here today – "how better to link the findings of research on the science of learning to actual practice in the classroom." And in his 2001 President's Address, Bruce Alberts, President of the National Academy of Sciences, challenged us to "make a science out of education." These two events helped shape a national agenda.

The key research findings and implications presented in *How People Learn* can be summarized as follows:

1. "Students come to the classroom with preconceptions about how the world works. And teachers must draw them out and work with the preconceptions. If students' initial understandings are not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom."

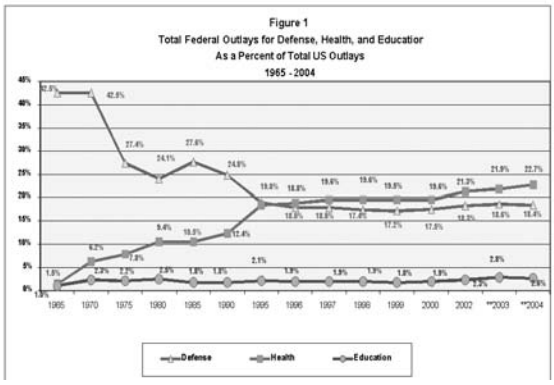
2. "To develop competence in an area of inquiry, students must have not only a deep foundation of factual knowledge but must (a) understand facts and ideas in the context of a conceptual framework, and (b) organize knowledge in ways that facilitate retrieval and application."

3. "A 'metacognitive' approach (and here metacognitive means, for example, monitoring one's own understanding, checking new information against the old, seeing analogies) to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them." (*How People Learn: Brain, Mind, Experience, and School,* National Academy Press)

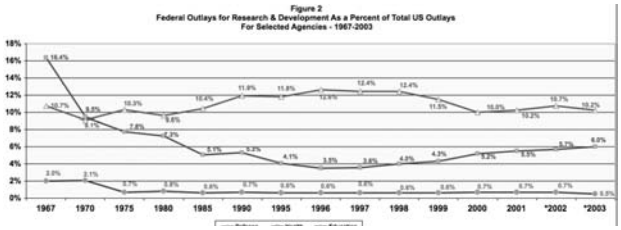
In October 2002, Congress passed legislation, the Education Sciences Reform Act (HR 3801) to replace the Department of Education's Office of Educational Research and Improvement with an autonomous Institute of Education Sciences (proposed "knowledge Utilization Office"), with a goal of infusing education research with "scientific rigor." A year later, in 2003-4, a new program of the National Science Foundation to establish some 15 to 25 national $5-million-dollar "Science of Learning Centers" had a similar mission to fund basic scientific knowledge about how people learn, in order to inform educational practice and policy.

These are all small steps in the right direction, shaping an agenda for research. But "Big Education," that is, large groups of interdisciplinary teams studying major education problems, has not emerged in educational research in the way the "Big Science" has brought us high-energy physics and the Human Genome Project. We have not invested in the research and development infrastructure of education in the way our society has invested in health and defense.

Here is the proof of that.



Here are total federal outlays for defense (in red), health (in green), and education (in blue) from the time data that were available from 1965 to the present. Nearly 40% of federal expenditures go to defense and health, and their proportions have undergone radical revision, from the early, gross predominance of defense to now nearly a 50/50 split, while expenditures for education have remained relatively flat at about two to two-and-a-half percent of the total. The vast majority of federal outlays on education in this country go to Pell grants, federal family education loans, and federal direct student loans. These are all highly necessary, but in the current discussions on the renewal of the Higher Education Act, discussion of financial aid virtually drowns out line items for research.



Now let's drill down on that two-and-a-half percent and see how much is spent on research and development. This graph displays the percentage of all outlays spent on research. Again defense is in red, health is in green, and education is in blue. The percentages of these three federal budgetary outlays given to R&D have remained steady at 10-to-12% for defense, 5- to-7% for healthcare, and bringing up the rear, at less than 1% for education research, and remaining completely flat throughout. This is despite the fact that this 37-year period, from the Vietnam War era to the Iraq War, saw the economic cycles of Carter-era inflation and Reaganomics, the graying of the population and the growth of Medicare, the biology and tech booms, the evolution of health-care and higher education as "rights," and the elevation of education to federal departmental status and a perennial top presidential campaign issue. Yet the expenditures for research in education remain flat.

The needs for research in education are huge. If we were forward-looking, small expenditures for research might have the power to revolutionize the delivery and experience of education.

Most Profitable US Companies in 2002: R&D*

Company Name	US Rank	Net Profit ($ Mil)	Total Revenue ($ Mil)	R & D Expenditures ($ Mil)	R&D as % of Revenue
Citigroup	1	15,323	93,041	n/a	–
General Electric	2	15,133	131,698	2,631	2.0 %
Altria Group	3	11,102	80,408	n/a	–
Exxon Mobil	4	11,011	204,506	631	0.3 %
Bank of America	5	9,249	46,012	n/a	–
Pfizer	6	9,181	32,373	5,176	16 %
Wal-Mart Stores	7	8,039	244,524	n/a	–
Microsoft	8	7,829	28,365	4,307	15 %
SBC Communications	9	7,473	43,138	n/a	–
Merck	10	7,150	51,790	2,677	5.2 %
Johnson & Johnson	11	6,597	36,298	4,146	11 %
Wells Fargo	12	5,710	28,473	n/a	–
Freddie Mac	13	5,530	n/a	n/a	–
American International Group	14	5,519	67,482	n/a	–
International Business Machines	15	5,334	81,186	4,750	5.9 %

•Source: BusinessWeek Online, *The 2003 Global 1000 Scoreboard*; and financial reports on corporate web sites. n/a, not available.
http://bwnt.businessweek.com/global_1000/2003/index.asp?sortCol=profits&sortOrder=DESC&pageNum=1&resultNum=25&country=)

Comparisons with the business world are illuminating. Pharmaceutical firms (highlighted in yellow) take huge risks with R&D, investing 5 to 16% of revenues for the potential enormous gains for them and for society. Other technology giants (highlighted in gray) – like GE,

Microsoft, and IBM - invest between 2 and 15%. In both kinds of industries, the concept of a research pipeline directly connected to future productivity is salient. By contrast, financial corporations and oil companies spend so little on research that research does not even make it as a line item onto consolidated financial statements.

By these comparisons, the federal budget for education is behaving more like the oil business than the discovery-oriented technology and pharmaceutical firms. But higher education is not in the extraction business, digging students out of high schools and efficiently refining them for the labor market. If education seeks to be more discovery- and risk-oriented, it needs to see its calling as the creation of greater inspiration and opportunity for research.

The public's confidence in education will be increased by valid and reliable research. Through research, we can become more efficient transmitters of the knowledge we create. Each of you can imagine just how efficient we might become if the budget for, say, just one five-billion-dollar aircraft carrier were spent on how to better educate the nation. So, in the end, what is the payoff for research? That is today's topic.

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Kuncl/Powerpoint.pdf

Research on Learning as a Foundation for Curricular Reform and Pedagogy

Speaker: *Elizabeth Ligon Bjork, Professor of Psychology, University of California, Los Angeles*

Over the last few decades, we have been learning a great deal about how people learn and the types of conditions that optimize long-term retention and transfer, and numerous findings from this research have important implications for ways in which we can improve instructional practice. In this presentation, I focus on those results indicating that in order to maximize the effectiveness of instruction and training, we need to pay greater attention to an old distinction in psychology—namely, the distinction between performance and learning—but in a slightly different way than researchers thought about this distinction in the past.

Early investigators of learning were forced to make a distinction between performance and learning when several, now classic, studies showed that—despite the lack of any evidence in an animal's performance during training—learning had nonetheless occurred and could be revealed under the right circumstances, such as when a food reward was introduced into the situation. More recently, a variety of results suggest that what we might think of as a corollary to this earlier distinction needs to be made. Specifically, whereas learning can be occurring with no apparent change in performance during training, improvements in performance during training can occur with little or no durable learning being achieved. Or, put slightly differently, conditions of instruction that make performance improve rapidly often fail to support long-term retention and transfer, while conditions of instruction that appear to create difficulties for the learner, often slowing the rate of *apparent* learning, can actually optimize long-term retention and transfer.

As a consequence of this corollary, performance during training can be a poor and unreliable guide to whether the type of learning that is the goal of our instruction—that is, learning that will be both durable and support transfer—has actually occurred. But, of course, what is readily observable to us as instructors is the performance of our students during instruction and training. Consequently, as instructors, we can easily be misled into using manipulations of training and instruction having the property of enhancing performance during training and instruction, but failing to support learning as measured by long-term retention and the transfer of skills and knowledge. And, conversely, as instructors, we can easily be led away from using conditions that introduce difficulties for the learner and appear to slow the rate of learning, but that are actually enhancing post-training retention and transfer.

A discussion of these latter types of conditions—originally labeled as "desirable difficulties" by Robert A. Bork (1994) to indicate their property of being conditions of instruction that seem to present difficulties for the learner, that appear to slow down the rate of acquisition, but actually result in better long-term learning and transfer—constitutes the remainder of this presentation. In this discussion, I hope to accomplish two main goals. First, I hope to give you a feeling for a few types of desirable difficulties, one of which I will also illustrate with experimental findings. And, second, in this context, I want to point out the potential for teachers and trainers—as well as students and trainees—to be misled as to what are and are not good educational practices or good conditions of learning.

As instructors, we can often be misled in this determination because what is readily available to us is the performance of our students during instruction, which can be a poor indicator of whether durable learning is actually occurring. If, for example, all we consider is the rapidity and apparent ease of their learning during training and instruction, we can easily be led into preferring poorer conditions of learning to better conditions of learning. Additionally, as learners, it seems that we do not develop—through the trials and errors of everyday living—an accurate mental model, so to speak, of those operations that result in learning and those that do not. Furthermore, we are fooled by certain indices—such as how fluently we process information during the re-reading of to-be-learned material—into illusions of learning and/or competence that then lead us to prefer poorer conditions of learning to better conditions of learning.

So, what are some of these manipulations or conditions of instruction that introduce desirable difficulties for the learner? I briefly describe five of them. Then, I illustrate one—providing contextual interference for the learner—with some experimental findings. Finally, I present a number of points that, as instructors, we should keep in mind to try to introduce some of these desirable difficulties into the design of our undergraduate courses and curricula.

Manipulations that Introduce Desirable Difficulties for the Learner

1. *Varying the Conditions of Practice.* When instruction occurs under conditions that are constant and predictable, learning appears to become what might be called contextualized. That is, while it looks very good in that context, the learning acquired in that context does not support retention later when tested in other contexts, and it does not transfer well to different contexts. In contrast, varying conditions of practice—even just the place where you study (as illustrated by Smith, Glenberg, & Bjork, 1978, and by Smith & Rothkopf, 1984)—can enhance recall at a later time. With respect to these findings, it is interesting to note that a how-to-study hint frequently given to students is that they should find a quiet, convenient place to study and then do all their studying in that same place.
2. *Providing Contextual Interference during Learning.* If when trying to learn several different things, you intertwine the learning of those things in such a way as to cause interference among them during acquisition, long-term performance on them will be enhanced. This type of desirable difficulty, often accomplished by interleaving the practice of the various things to be learned, rather than blocking their practice, is the desirable difficulty that I will illustrate with

some relevant experimental findings.

3. *Distributing or Spacing Study and Practice*. The effects of distributed practice on learning are somewhat complex. Although massing practice (e.g., cramming for exams) supports short-term performance, spacing practice (e.g., distributing presentations, study attempts, or training trials) supports long-term retention. That the spacing of practice enhances long-term performance is among one of the more robust and general findings in learning research, holding across a variety of spacing intervals, types of materials, and types of learners. Unfortunately, however, because massed practice or study can support short-term performance, students can be rewarded by good test performance following an all-night cramming session. Little of what they were able to recall after such a short delay, however, will still be recallable after a more substantial delay; whereas, had they distributed their study, much more of the to-be-learned material would still be recallable after a long delay. If throughout the duration of a course, students simply cram for each exam and there is no cumulative final for which they must go back and re-study information already tested, it is little wonder that most students appear to retain very little of the content of a course they had presumably mastered within even a moderate delay from having completed it.
4. *Reducing Feedback to the Learner*. That reducing feedback to the learner during acquisition could be a desirable difficulty seems very strange. Indeed, for many years in the area of motor-skills learning, it was thought that the more feedback you give the learner, the faster and better the learning would be. More recent work, however, has shown that by reducing the feedback you actually enhance the long-term retention and generalizability of motor skills—that is, the ability to produce those skills accurately after a long delay and under different circumstances. (For reviews of the work supporting this new view of feedback and why reduced feedback leads to more durable and flexible learning, see Schmidt & Bjork, 1992, and Christina & Bjork, 1991.)
5. *Using Tests (rather than presentations) as Learning Events*. Much research in the laboratory (e,g., Landauer & Bjork, 1978; Carrier and Pashler, 1992) has demonstrated the power of tests as learning events and, indeed, in terms of long-term retention, such research has demonstrated that a test or retrieval attempt, even when no corrective feedback is given, can be far more effective than a second presentation or study opportunity. In addition, much current research is being addressed to questions concerning test effects, such as the optimal distribution of tests, the optimal form of tests for different types of delays and materials, and the optimal use of feedback with respect to testing outcomes. I do not have time to cover this work in today's talk, but before leaving this topic, I do want to make two points relevant to testing effects.

First, it seems clear that the value of tests as learning events is greatly underappreciated in most educational contexts, where, instead, tests are primarily viewed as assessment tools. Clearly, those of us who study learning in the laboratory must do a more effective job of communicating to teachers and instructors, in general, about the power of tests to promote learning, not just assess it. To address this need, Roediger and Karpicke (2005) at Washington University are currently looking at testing effects with educationally realistic materials and are obtaining dramatic and compelling evidence concerning the benefits of testing over representations of material. As more of these types of results, obtained with such materials, become available, our ability to communicate to teachers and instructors regarding the effectiveness of tests as learning events should be greatly improved. (For references demonstrating the effectiveness of tests as learning events and discussions of why tests are so effective, see Bjork, 1975; Bjork & Bjork, 1992; & Carrier & Pashler, 1992; and for a review of this literature, see Dempster, 1996.)

Second, because students, by and large, do not realize that tests—or attempts to retrieve information—are more effective in promoting learning than are repeated presentations of the material to be learned, they are led to adopt highly inefficient study activities. Were we, for example, to follow some typical students around campus and watch how they went about studying, we would find that they spend way too much time representing information to themselves—reading a chapter over and over again, highlighting passages in different colors, and so forth—and far too little time trying to retrieve information. Or, put slightly different, they would be spending far too much time on the input side of learning and far too little time on the output side of learning. That this mode of studying is so typical among students stems, at least in part, from a faulty mental model of how we learn and remember. They, as many of us do, tend to think of memory as being too much like a tape recorder. Thus they feel that if they just present materials over and over again to themselves, eventually it will write itself on their memories. As it turns out, however, nothing could be further from the way we actually learn and remember.

Contextual Interference as a Desirable Difficulty

I turn now to the desirable difficulty of contextual interference and to demonstrate it with some empirical studies. In the first study I discuss, by Shea and Morgan (1979), contextual inference during learning was provided by having some subjects learn three different movement patterns in an interleaved manner, while others learned them in a blocked manner. The apparatus used by Shea and Morgan looked somewhat like a pinball machine, having two vertical rows of hinged paddles on each side with a start button and a hole containing a tennis ball located between these two rows. In addition, located at the back of the apparatus were three differently patterned stimulus lights, each of which was associated with a different movement pattern that the participant was to learn. When one of the lights came on, the participant was to: 1) push the start button; 2) pick up the tennis ball; 3) while holding it, knock down the paddles in the manner associated with that particular light (e.g., knocking down the first paddle in the left row, then the middle paddle in the right row, and then the rear paddle in the left row); and, 4) when finished, return the ball to its initial location, which turned off a response timer.

In the blocked condition, participants learned the three movements by practicing only one pattern at a time in a blocked manner. For example, a given participant would practice the first pattern to be learned, say A, for many times in a row, then movement pattern B for the same number of trials, and then movement pattern C, also for the same number of trials. For participants learning in the interleaved (or random) condition, the light designating a given movement, say A, might come on for the first practice trial, then the light designating movement C, then A again, then B, then C, and so forth, in a random order, until the participant had practiced each movement pattern for the same number of trials as had the participants in the blocked condition.

As might be expected, during training, the performance of the participants given blocked practice improved much more rapidly than did that of the participants in the interleaved or random condition. Although performance in the interleaved condition eventually caught up to that in the blocked condition, it took quite a while for it to do so—essentially, twice as long to attain the same asymptotic level of performance. If Shea and Morgan had ended their study at this point, and, thus, all the results available to us would have been the participants' performance during acquisition or training, it would seem clear that blocking of practice trials was the superior leaning procedure. But, fortunately, Shea and Morgan did not stop their study at this point. Rather, they had participants return after 10 days at which time they were given a

retention test on the movement patterns—a final exam, so to speak. What happened on this exam was quite dramatic!

Shea and Morgan tested their participants in two ways: either under conditions that matched those present during training or under conditions that did not. Thus, for participants trained initially in the blocked condition, half were tested under blocked conditions again and half were tested under interleaved or random conditions. Similarly, for participants trained under interleaved or random conditions, half were tested under the interleaved conditions again and half under blocked conditions. When testing was done under interleaved conditions, the participants who had been trained under those conditions performed essentially as well as they had on their last day of training—that is, they showed little or no forgetting of the three movement patterns. In dramatic contrast, those participants who had been trained under blocked conditions—the participants who had looked the best during training—performed exceptionally poorly on the test. Indeed, their performance was so poor as to look like they had never been trained in the first place. When participants were tested under blocked conditions, the performance of participants trained under blocked conditions was much better, showing only a small amount of forgetting, but—of greater importance—the performance of participants trained under interleaved conditions also showed little or no forgetting. Indeed, if anything, their performance was better—even when tested under blocked conditions—than that of the participants originally trained in that manner.

In other words, when participants trained under blocked conditions were later tested under conditions not identical to those present during their training, their performance was extremely poor, essentially looking like they had never been trained at all. In contrast, participants trained under interleaved conditions were not only able to perform with little or no forgetting when tested under the same conditions, they were also able to perform with little or no forgetting under changed conditions. This pattern of results thus provides a dramatic illustration of the benefits of introducing contextual interference into the learning process. Although slowing acquisition during training relative to blocked practice, the contextual interference introduced by the random practice procedure served to enhance performance at a delay and in a different context.

Several possibilities have been advanced in the literature to explain why interleaving might be so beneficial for long-term retention and transfer. One of these (e.g., Battig, 1966) is in terms of the learner having to resolve the interference among the different things that he or she is trying to learn. To accomplish this resolution, the learner has to notice similarities and differences among them and to schematize or develop a more abstract representation of each item or movement. This higher-order type of learning is what permits both long-term retention and transfer. Another explanation assumes that what is beneficial in the interleaving procedure is that it forces us, as learners, to reload our memories for the different things we are trying to learn over and over again. If required to do A, then B, then C, and then B again, the memory for how to do B is not just sitting there in short-term memory waiting for us to access with no effort. Instead, we have to retrieve it again from long-term memory. These successive attempts to retrieve things that have been forgotten from short-term memory are what lead to the enhanced long-term retention in the interleaved situation. (For a discussion of forgetting as a condition for learning, see Bjork, 1994; Estes, 1955; and Cuddy & Jacoby, 1982.)

While the results of the Shea and Morgan study illustrate how we, as instructors, could easily be misled by the performance of our students during instruction or training into preferring a condition of instruction that is actually not supportive of long-term retention and transfer over one that is, the next study I describe illustrates how we, as learners, can similarly be misled into preferring poorer conditions of learning to better conditions of learning. In this study, conducted by Simon and Bjork (2001), participants also learned three different movement patterns, and they also learned them in either a blocked or interleaved (random) order. Rather than knocking down paddles, however, participants in the Simon and Bjork study learned to execute three different movement patterns on a computer number pad in a specific amount of time (i.e., 900, 1200, and 1500 milliseconds), and they were given feedback on how close they had come to the required duration after each trial. Twenty-four hours after their training, participants returned to the lab and were tested on the three movements. Consistent with the results of Shea and Morgan, participants who learned under blocked training performed better during acquisition; but 24 hours later, they performed more poorly than the participants who had received the random or interleaved training.

The new wrinkle in the Simon and Bjork study was that participants were periodically stopped during training and asked to take a reading on how well they were learning the task. They were asked, if you were to stop training right now and come back in 24 hours, how well do you think you would do—that is, how close do you think you could come to the correct movement time. Participants in the blocked condition all predicted that they would do better than the participants in the interleaved condition predicted that they would do. In other words, their meta-cognitive assessment of how well they were going to do later was exactly wrong. Participants in the blocked condition most likely mistook the rapidity and apparent ease of their being able to perform the required movement patterns—made possible by the blocking of practice trials—as indicating that they were actually learning them well; whereas, the participants in the interleaved condition most likely mistook the slowness and apparent difficulty with which they were being able to perform the required motor pattern as indicating that they were not learning them well. (For a relevant discussion of such confusion between performance and learning in terms of the difference between the retrieval strength and storage strength of memories, as hypothesized in a new theory of disuse, see Bjork & Bjork, 1992.)

Thus, taken together, these two studies illustrate both how we, as instructors, can be misled if we only attend to or only have available to us the performance of our students during acquisition, and how we, as learners, can be misled into thinking that we are learning better under one condition than another when, in fact, the opposite is true. Unfortunately, as learners, we do not seem to be very good at assessing our actual state of competence or knowledge during training and seem easily misled concerning the conditions of training and instruction that are optimal. We seem, for example, to intuit that we are learning better under massed as opposed to spaced conditions of practice, or when the conditions of learning are kept constant as opposed to varied, or when we are given more rather than less feedback. Apparently, these conditions—because they support our performance during training—give us a sense of ease and a sense of learning that turns out to be misleading as far as the actual long-term learning that we are achieving. Whether or not, we, as learners, could be made to be more meta-cognitively sophisticated with respect to when we are or are not learning well is a topic of considerable research interest right now. (For a more thorough discussion of factors that can lead to such "illusions" of knowledge and/or competency, see Bjork, 1999, and Jacoby, Bjork, & Kelley, 1994).

Now, in case by the studies I have used so far to illustrate the benefits of contextual interference, I have created the impression that this desirable difficulty only works with motor learning or simple materials, I end by describing two studies using more educationally relevant materials. In the first study, Mannes and Kintsch (1987) examined the

effects of contextual interference on learning from the reading of text. Participants were given a certain period of time to study a technical, but somewhat interesting article on the industrial use of microbes and bacteria with the clever title, "Industry in Ferment." Prior to studying this article, however, participants had either been given a consistent or an inconsistent outline to read. The consistent outline had the same structure as the article and 25% of the information in the article was presented in the outline; thus, it was very much like the type of advanced organizer frequently used in educational settings. The inconsistent outline had all the same factual information—thus it too had 25% overlap with the "Industry in Ferment" article—but it was actually the outline of an *Encyclopedia Britannica* article on microbes and, thus, it mismatched the article in a number of ways. After participants had studied their assigned outline and then the article, different types of tests were administered. When given a straightforward, verbatim recall kind of test, participants who had received the consistent outline performed better. When given a test that involved problem solving and a deeper understanding of the article, however, the participants who had received the inconsistent outline performed better.

How can we explain this pattern of results? Mannes and Kintsch argued that the inconsistent outline created contextual interference for the readers, forcing them to engage in more active processing of the material in order to resolve this interference. To make peace, so to speak, between the two sources of information, these readers were forced to notice similarities and differences between them and to make inferences in order to bridge gaps between them. Consequently, the readers in the inconsistent-outline condition achieved a deeper understanding of the material than did those in the inconsistent-outline condition.

Although Mannes and Kintsch did not do so in this study, it is interesting to speculate what they would have discovered had they asked their participants how helpful they had found their outlines to be. Participants receiving the consistent outline would probably have given the outline high marks. But what about the participants in the inconsistent condition? Most likely, they would not have given their outline high marks. In fact, they would probably have complained about its inconsistency with the article, even though it was probably in the resolution of these inconsistencies between the outline and the article that learning of a deeper kind was taking place. Almost certainly, however, like the participants in the interleaved versus the blocked conditions of the Simon and Bjork study, these participants too would not have been able to appreciate the better learning being produced by the inconsistent versus the consistent condition.

Finally, in the last study that I want to share with you; McNamara, Kintsch, Songer, and Kintsch (1996) introduced desirable difficulties into their participants processing of text by creating two different levels of coherency in a text about heart disease. Additionally and interestingly, they also had participants with different levels of background knowledge in the domain of biology read the two different levels of text. They then tested their participants regarding the text in a variety of ways by asking them different types of questions - some text-based and some requiring the making of inferences or the solving of problems. Although it was more complicated study than I am describing now, the two hypotheses of relevance to the present discussion were that (a) for both types of students, the consistent outline should be better for the straight recall of text information, but (b) for students with the requisite background knowledge, the text with low coherence could be more beneficial than the test with high coherence. Similar to the reasoning as to why the inconsistent outline was beneficial for deeper learning, the idea behind the second hypothesis was that such students may learn better when they have to provide the coherence themselves (e.g., make the inferences and provide the explanatory connections that are not explicitly provided in the text, thus integrating the information in the text with the information they already have stored in long-term memory.) In contrast, students without the requisite background knowledge would not be able to make the necessary inferences nor fill in the gaps. For them, then, the low coherence in the text would not be a desirable difficulty, as it would present them with difficulties that they would not be able to overcome.

As predicted, for text-based recall of information, the high-coherence text was found to be better for both high and low knowledge students. And, also as hypothesized, for questions requiring problem solving or the making of bridging inferences, the high-knowledge students did profit from having to deal with the low coherent text. In contrast, but as predicted, for the low-knowledge students, the low-coherence text created difficulties that they could not overcome. Thus, for them, the low coherency of the text was not a *desirable* difficulty.

Concluding Comments

I hope in this discussion, I have been able to convince you of the need for us to take a new look at our own methods of instruction and how we design and organize our courses with an eye for introducing desirable difficulties for our students. In doing so, however, we need to keep a few points in mind. First, we need to be mindful of how easy it is for us, as instructors, to be misled regarding the optimal conditions of instruction. In particular, we need to be wary of preferring conditions that speed acquisition and seem to make the learning process too easy, as these conditions may simply be propping up the temporary performance of our students and not creating the type of learning that can lead to long-term retention and transfer. Furthermore, in making decisions regarding how to optimize the learning of our students, we must keep in mind that we cannot rely on the meta-cognitive reports of our students, who themselves—as learners—are often misled into preferring non-optimal to optimal conditions of learning. We want to introduce procedures that present difficulties for the learner—in general, difficulties that force the learner to be a more active participant in the acquisition process. At the same time, however, we need to insure that the difficulties we introduce are, in fact, desirable difficulties, that is, ones that the learner is capable of overcoming.

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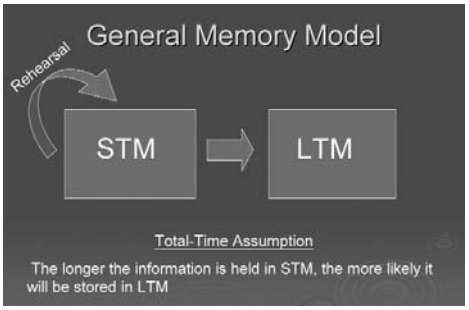
Improving Student Learning: Moving from the Memory Laboratory to the Classroom

Speaker: Mark A. McDaniel, Professor of Psychology, Washington University in St. Louis

My primary focus this afternoon reflects the observation that at the college level, especially in foundation courses, much learning consists of the acquisition of factual information. For example, in introductory geology, students must master knowledge of multiple characteristics of types of rocks; in political science, students need to thoroughly learn a number of characteristics associated with each of a few types of political systems; and in developmental psychology, students must learn the attributes of a variety of theories of development (Pressley, Symons, McDaniel, Snyder, & Turnure, 1988).

From the perspective of a standard information processing model of memory, the challenge for the student is to transfer facts from the short-term memory (STM) store, where the facts reside in awareness when immediately attended, to a more permanent long-term memory (LTM) (see Figure 1 below). Extensive research in the memory laboratory has embellished this simple model. In this paper I will examine a number of implications from the basic memory model that potentially translate into improvements in student learning and classroom practice. To meet this objective, I will identify several key components of the memory model and briefly summarize the lessons learned in the memory laboratory. For each, using educational materials, I will then present translational research that informs techniques and approaches to improve student learning in fact-laden courses.

Figure 1



The likelihood of transfer from STM to LTM was originally assumed to be a positive function of the amount of time information resided in STM (the Total-Time Assumption). Because rehearsal—recycling information in STM—is the control mechanism by which the learner maintains information in STM, the total-time hypothesis implies that the more the learner rehearses target information, the more likely that the information will be stored in LTM. Basic memory research, however, has not supported the total-time hypothesis. Yet, for many students their typical study activities such as rereading text and lecture notes seem to heavily engage repetitive recycling of the information. Accordingly, the first implication for undergraduate education is that typical undergraduate study activities like rereading the text and notes may not be overly effective for learning and retention. The assumption here is that rereading for undergraduate students often involves repetitive recycling, and memory theory suggests this is not overly effective for increasing learning. Let's examine relevant research with educational type materials.

Roediger and Karpicke (in preparation; Figure 2 below) found that extensive rereading of a text in three study sessions produced only a modest gain in recall relative to several rereadings in one study session. Perhaps, most of the learning gain occurred in the first several rereadings and then reached a ceiling. Callender and McDaniel (Figures 3-4 below) showed that there was no apparent gain in learning from one to two readings, regardless of test type. Performance after one reading was relatively high, however. What about a text for which performance after one reading is at lower levels? Even in this situation, Amlund, Kardash, and Kulhavy (1986; Figure 5 below) reported only slight gains in learning of main ideas from one to three readings.

Figure 2

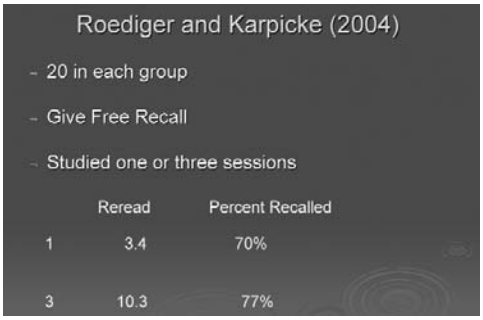


Figure 3

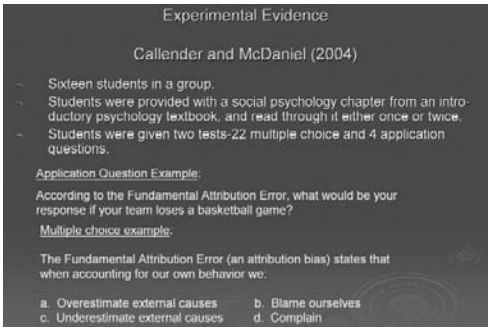


Figure 4

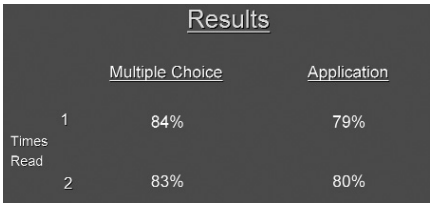
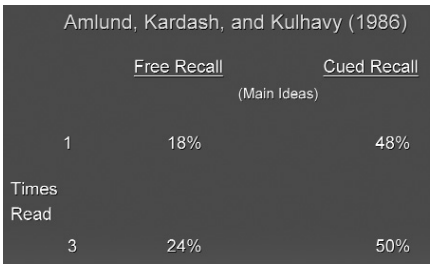
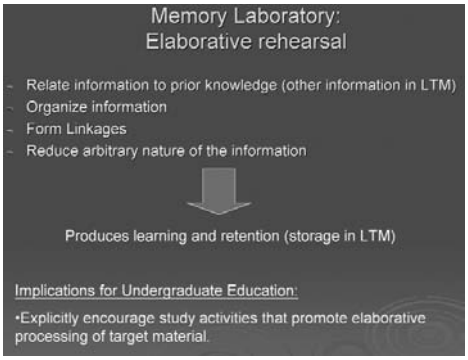


Figure 5



Memory research indicates that elaborative rehearsal (see Figure 6 below), which involves relating, organizing, linking and synthesizing information produces learning and retention. The implication for undergraduate education is that instructors should encourage study activities that promote elaborative processing of target material. In the memory laboratory, elaborations are provided for the subject, but in college settings, students may have to recruit elaborative learning processes on their own. One technique to stimulate elaborative learning is to generate answers to "why" questions for facts to be learned. This technique is elaborative interrogation. Experiments with educational materials demonstrate the effectiveness of elaborative interrogation (e.g., Pressley et al., 1988). Indeed, McDaniel and Donnelly (1996) showed that elaborative interrogation improved both inference and fact level performance, whereas traditional keyword highlighting presentations had no benefit.

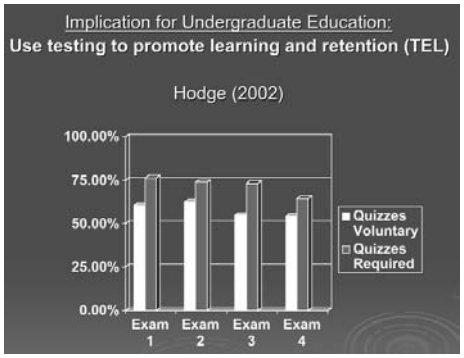
Figure 6



Retrieval and Learning

A key process in using information stored in LTM is the retrieval of that information into awareness (STM). Basic memory research shows that retrieval (recall, recognition) enhances subsequent retention. The implication is that testing should be used to promote learning and retention. A powerful demonstration of test-enhanced learning in the classroom is provided by Hodge (unpublished data) who showed that frequent quizzes in his introductory psychology class resulted in subsequent improvement in exam performances relative to a parallel section in which quizzes were not required (Figure 7 below).

Figure 7



There are a variety of ways in which these quizzes may confer learning benefits in educational settings.

1. They require students to engage in the material (Figure 8).
2. They signal information that the student needs to target for learning (Figure 9).
3. Retrieval itself produces enhanced encoding (Figure 10).

Figure 8

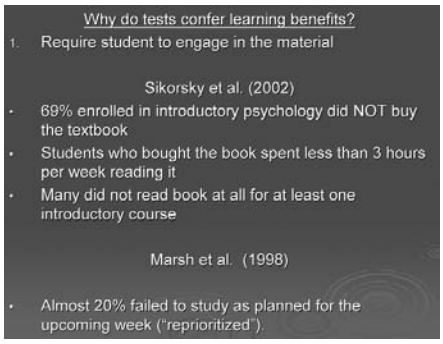


Figure 9

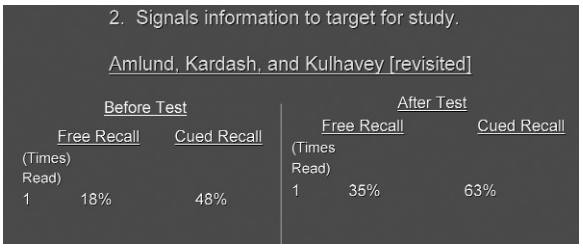
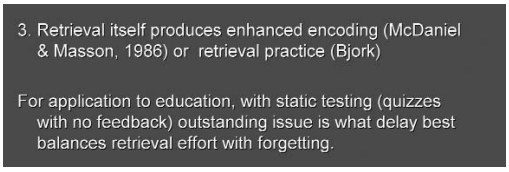


Figure 10



Evidence to support the above claim may be found in the work of Hanson and McDaniel (unpublished data; Figures 11-15) and McDaniel, Anderson, and Morrisette (unpublished data; Figures 16-20).

Figure 11

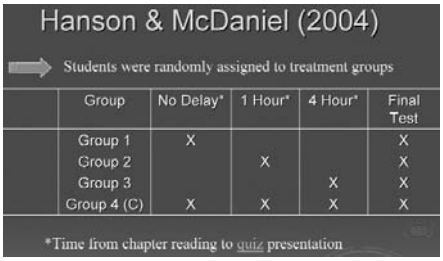


Figure 12

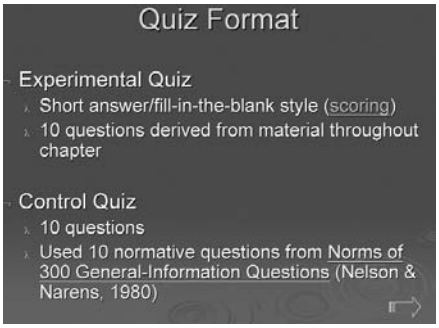


Figure 13

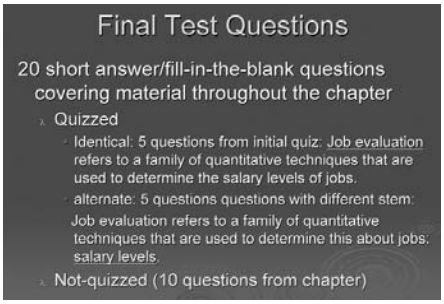


Figure 14

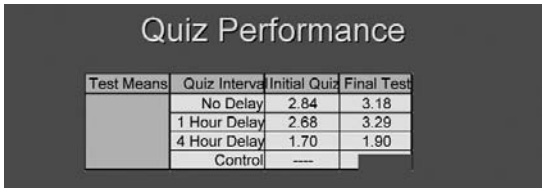


Figure 15

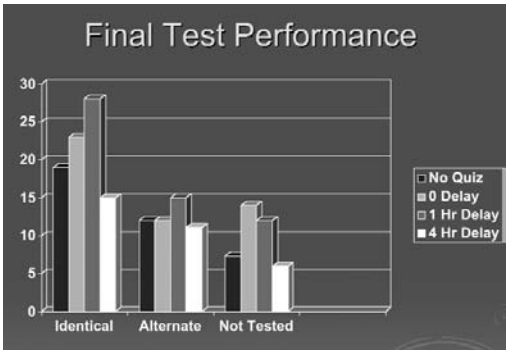


Figure 16

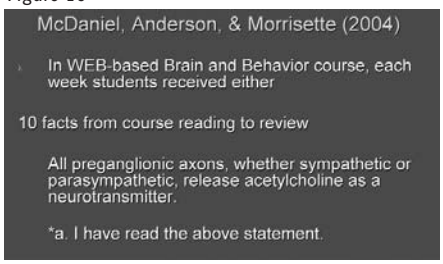


Figure 17

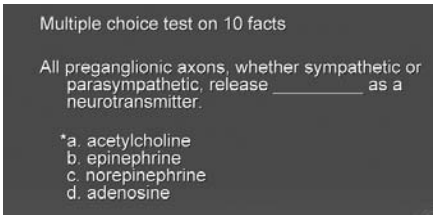


Figure 18

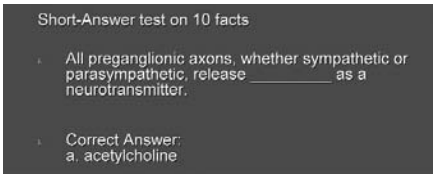


Figure 19

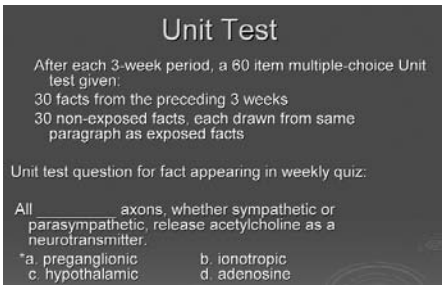
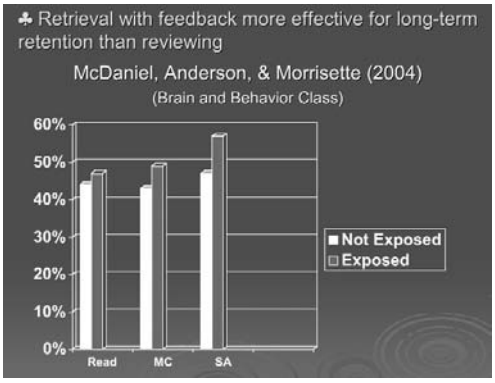
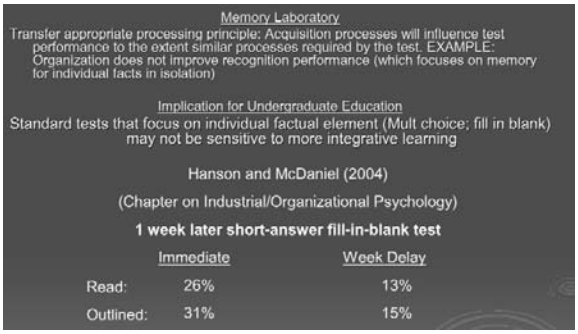


Figure 20



Finally, a well-supported principle from the memory laboratory is that of transfer appropriate processing. A given test is not necessarily sensitive to all components of what has been learned. For undergraduate education, tests should be designed to be sensitive to the kind of knowledge desired and should reinforce desired learning. For instance, standard multiple choice tests and recall of individual facts can lack sensitivity to organization of content (elaborative rehearsal that leads to good long-term retention (See Figure 21). Accordingly such tests may discourage student use of one of the most frequently recommended constructive study activities, outlining.

Figure 21



As another example, in the classroom tests may focus on use of information within a range of instruction (interpolation tests). In laboratory experiments, in the domain of learning functional relations (akin to science lessons in which the relation between the mass hung from a spring of given tensile strength and amount it stretches is taught by varying the mass), we have shown that these tests do not successfully reveal what has been learned. Extrapolation tests may better assess what has been learned (Figures 22-24).

Figure 22

Figure 23

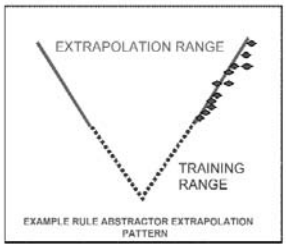
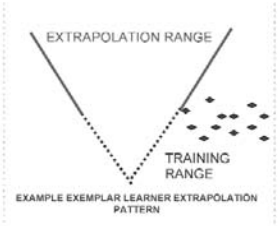


Figure 24



In conclusion, the data indicate that study processes should encourage elaboration rather than repetitive rehearsal; frequent testing is valuable for enhancing learning; and the nature of the test is critical for revealing what is learned (some tests may reinforce less powerful study processes).

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www.sunysb.edu/Reinventioncenter/Conference_04/McDaniel/Powerpoint.pdf

Disciplinary Differences in Learning and Thinking Processes and in Instructional Strategies

Speaker: Janet Gail Donald, Professor of Education and Counseling Psychology, McGill University

In this panel presentation, we were asked to respond to the challenge of translating research findings in the science of learning into educational applications. To do this, we were asked to provide you with an overview of the current state of research on learning, to consider how the effective application of relevant principles can improve faculty teaching and student learning, and to examine challenges of application within the research university context. As preamble to my talk, I will provide my disciplinary context: although I had a solid liberal arts and science undergraduate education, I grew up as a psychologist, and I became an educational researcher, in fact was the first PhD graduated from the Ontario Institute for Studies in Education at the University of Toronto. I am thus a hybrid, and although I honor my roots in philosophy and psychological theory, I also have the need to test the principles derived from these disciplines in the field. I embody the skepticism of the engineer, asking, "Will this work?" My field is teaching and learning in higher education, and I have spent the last thirty years examining how professors in different disciplines teach, how students learn, and how we might optimize student learning. In this presentation two questions guide my search: What do we know about student learning? What instructional strategies will help students learn to think?

What Do We Know About Student Learning?

Helping students learn would appear to be a straightforward goal, but there are many ways of perceiving postsecondary teaching and learning. From the perspective of faculty, learning is a matter of disciplinary knowledge and methods of inquiry, but the expectations of students differ across disciplines. Most physics professors expect students to enter their programs with a high degree of logical ability, while English professors expect students to learn to argue logically in their courses (Donald, 1988). Law professors expect students to learn to think like a lawyer, to acquire the skills and methods of analysis and procedure (Donald, 2002). Since scholars learn and think within disciplines, an important source for what is to be learned is what our disciplines tell us, particularly the methods of inquiry used and the learning tasks prescribed by these methods. Learning theories have a more general effect, influencing what happens in the classroom and how learning is assessed. The experience of adapting to university may lead students to view learning from a very different perspective, "What do I need to do to survive and succeed?" Recognizing this range of perspectives is a first step in responding to the challenge of translating research on postsecondary learning into educational applications.

Disciplinary Differences

The primary source of *what* is to be learned is the discipline. But disciplines are moving targets, uncertain constructs we can only hope to place within certain parameters. Disciplines are classically defined as domains of knowledge that include specialized vocabularies and accepted theories, systematic research strategies with techniques for replication and validation (Dressel & Mayhew, 1974). Among disciplines, the most prototypical are the physical sciences, which have been described as hard, well structured, or paradigmatic (Frederiksen, 1984; Kuhn, 1970). A paradigm consists of a logical structure and governing truth criteria that provide maximum direction to scholars in the field (Kuhn, 1970). In physics, for example, Newton's laws of classical mechanics form part of the curriculum around the world. The theories that describe physical phenomena, however, are often incongruent with experience, and to be able to problem solve, the main task in the physical sciences, students must frequently make a radical change in their conceptual framework from Aristotelian to Newtonian.

In the social sciences, phenomena are examined at a broader or more general level than in the physical sciences, and one of the learning tasks is to choose among various theoretical frameworks that could describe the phenomena (Donald, 2002). For example, in psychology, there are several models of learning and of human development. In comparison with the physical sciences, where abstract concepts are proven by concrete experiments, in the social sciences multiple variables and their interaction render theories more difficult to test. Methods of analysis therefore assume greater importance in the curriculum, and the student's task is to locate, recognize and attempt to relate the varied conceptual frameworks within a discipline.

The humanities specify different tasks again. Often they are described as a training in sensibility, and an aesthetic criterion is applied to learning (Donald, 2002). Humanistic truth involves authenticity or genuineness rather than logical or scientific validity (Broudy, 1977). There is a technical language to be learned, however; for example, *trope* or *genre* in English literature. The student's task is to learn how to interpret text using the specified terminology, and how to present an argument. The learning tasks for students in physical and social sciences and the humanities thus differ considerably, and students must adopt a different approach in order to be successful in each of them. In physics, for example, the student must analyze a problem by breaking it down into its elements, then reconstitute or represent the problem. The student in psychology must wrestle with contrasting perspectives or theoretical frameworks in order to approach intellectual closure, but at the same time, needs to be skeptical and to continually search for consistency to validate findings. In English literature, the processes of argument and judgment provide the structure for learning.

Methods of Inquiry

The methods of inquiry espoused by disciplines may be part of their heraldry, but they often cross disciplinary boundaries. The earliest method, *hermeneutics*, or interpretation, was developed in order to analyze biblical text (Table 1). It is the construction of textual meaning which elucidates the connotations that text explicitly or implicitly represents (Hirsch, 1967). The interpreter of the text begins by assuming that the text is coherent, then develops a framework of explanation which is tested by the facts it generates. The method is thus a process of hypothesizing and then searching for corroborating evidence in the text. Although the hermeneutic approach is espoused most frequently in the humanities, discourse analysis as currently utilized in the social sciences owes much to hermeneutics.

A method more generally referred to across disciplines, *critical thinking*, developed out of the Socratic tradition of disciplined inquiry. Defined as a reasoned or questioning approach in which one examines assumptions and seeks evidence (Donald, 1985), researchers suggest that critical thinking includes components of logic, problem solving and Piagetian formal operations (Meyers, 1986; Sternberg, 1985). Different disciplines focus on different aspects of critical thinking - inferential processes in physics compared with testing assumptions in English (Donald, 1985; Meyers, 1986).

Table 1. Methods of inquiry in different disciplines

Method of inquiry	Examples of disciplines
Hermeneutics Interpretation, the construction of textual meaning through a dialectic between understanding and explanation	Biblical text, English literature, social sciences (discourse analysis)
Critical thinking A reasoned or questioning approach in which one examines assumptions and seeks evidence	Philosophy, English literature
Problem solving Steps for formulating a problem, calculating and verifying the logic used	Physics, engineering
Expertise Well developed representation of knowledge, action schemas	Physics, education, professions

In comparison to critical thinking, *problem solving* is described more specifically and procedurally as a set of steps consisting of formulating or representing a problem, selecting the relations pertinent to solving the problem, doing the necessary calculations, and verifying the logic used to see if the final answer makes sense (Reif, Larkin & Brackett, 1976). Thus problem solving includes critical thinking processes but, in addition, those of implementation or testing; the difference between critical thinking and problem solving is analogous to understanding versus doing. For example, the critical thinker would examine underlying assumptions and deduce their effects; the problem solver would continue from this action to create a strategy for dealing with the problem. Problem solving is most frequently used to describe inquiry in the physical sciences.

A more recent approach to understanding methods of thinking is to examine *expertise*, because the expert is one who has acquired not only a solid base of knowledge but the ability to apply it (Ericksen & Smith, 1991). The expert in a given area has well-developed representations of knowledge or schemas in the subject matter and can relate the schemas in order to operate intelligently. Research on the development of expertise provides insight into potential pedagogical practices. For example, studies on expert and novice differences reveal that novices use knowledge of surface structures while experts use action schemas (Chi, Feltovich & Glaser, 1981); novices represent problems literally while experts use a scientific and mathematical representation (McDermott & Larkin, 1978). Novices become experts by passing through a stage of analysis where problem solving time increases until they develop the representations and strategies characteristic of the expert. Experts recognize patterns and solve problems efficiently and effectively. They have a sense of the context or parameters, select appropriate information, recognize organizing principles, and verify their inferences. Their action schemas equip them with representations and thinking strategies for applying these representations to problems. What is particularly important about this approach is that it describes the relationship between knowledge and thinking processes, and contrasts the thinking strategies of novices and experts, thus opening the way to promoting such strategies.

Learning Theories and Implications for Instruction

Compared with the methods of inquiry used in disciplines, the influence of learning theories on classroom practice and the assessment of learning is more pervasive though tacit. The history of learning beginning with the earliest universities provides context for this discussion. Scholastics in the middle ages assumed a fixed body of knowledge; they defined that knowledge and were the authorities (Johnston, 1998). The enlightenment and the scientific revolution that followed it challenged the notion of fixed knowledge; a tenet of the revolution was that knowledge was an expanding and open system. Validity was now based in scientific measurement, and dissent was integral to the process of testing hypotheses. The role of the university changed to that of creator of new knowledge, a major transformation in epistemology that led to the increasingly important role of research in the university. It could be expected that the principle of an expanding universe of knowledge would guide instructional practice. But we are still dealing with the quandary of what is foundational or 'must be learned first' in many disciplines versus testing hypotheses as a way of learning.

What theories of learning have guided practice inpostsecondary education? The discipline of psychology has assumed primary responsibility for the topic of learning, and asks the question, 'How does learning occur?' The generally accepted definition of learning - *a relatively permanent change in behavior that occurs as a result of practice* - renders learning scientifically testable, that is, measurable, but it has certain limitations. The primary limitation is that in order to be measured, the learning task may be construed in an oversimplified manner. This definition of learning is most frequently interpreted reductively as association, that is, a connection between a stimulus and a response. The focus is on specific connections, and practice or repetition explains the process, consistent with experimental findings.

Early learning theories promoted this atomistic approach. In experimental studies of learning, Ebbinghaus in 1885 conceptualized human learning as a process of memorization, especially by repetition, so that one can repeat or reproduce. The emphasis on scientific measurement led him to reason that because words have many previous associations, to control the learning and recall of material, he would use nonsense syllables like *glet* or *roit* to study human learning (Woodworth & Schlosberg, 1954). Absent in his reasoning was comprehension that he was thus rendering learning nonsensical. Ebbinghaus' conception of learning as memorization was accompanied by a model of measurement that still guides much assessment practice. He postulated that there were four stages of memory: impression, retention (persistence of changed performance), recall (reproduction of once learned items) and recognition (awareness of previous experience). We set examinations to measure our students' recall and recognition. The limitation of this model is that it does not explain the more complex task of testing our students' understanding of pattern and relationship and their methods of inquiry.

A second early theory of learning focused on the effect of practice. Thorndike in 1914 applied the law of effect, originally developed to explain animal training, to human learning. The *law of effect* stated that satisfaction following from an act strengthens the bond and leads to its repetition, while annoyance weakens the bond. Satisfaction and annoyance were conceived in terms of synaptic functions, and were thus coherent with biological theory. His *law of exercise*, that the use of a given connection between a stimulus and a response strengthens the bond, is consistent with the associationist model, and with the saying that practice makes perfect. It is reflected in more recent biological approaches to pedagogy in which learning is described as a process of burning in mental circuitry (Leamnson, 1999). It too, however, neglects the effects of complexity and higher order learning.

The first breakthrough in terms of paying attention to higher order processing was Shannon and Weaver's (1949) information theory, which drew on communications theory to explain how messages or signals are sent and received. The prototype of an information channel is a perfect telephone line in which information transmission is complete, but

information theory took into account the fact that channels do not deliver total output and the receiver is left with some uncertainty (Berlyne, 1965). The receiver may also select information to reduce the uncertainty, and complexity of form influences information transmission. Thus information theory, in which information is encoded and in the process transformed and actively retrieved, is closer to a model of active or directed learning. Information theory also updated theories of memory: the concepts of immediate or short term memory and long term memory were introduced to discriminate between the limited capacity of an individual to attend to data – the magical number seven plus or minus two (Miller, 1956), and semantic or mediated memory.

A more molar approach, based in gestalt psychology which looks for principles of synthesis or organization, pays attention to a wider array of variables influencing learning. One is the tendency or need to categorize or group information, and another is the tendency to encode new information in terms of extant categories. The articulation of new knowledge with already existing knowledge requires attention to what the learner brings to the classroom. Learning therefore depends upon discovering relationships between the concepts or ideas presented and the learner's extant experience. Patterns of knowledge exist in *schemas* or cognitive structures, coherent plans displaying the essential or important relations between concepts which learners actively create. This model is coherent with the notion of expertise. The question of *why* an individual learns led Tolman (1932, 1949) to postulate that the organism responds purposefully and selectively to its environment. Learning is goal oriented. These more molar approaches to learning were the basis for cognitive theory (Woodworth & Schlosberg, 1954) and, more specifically, *constructivism*, in which individual learners construct their own understanding of organized public knowledge.

Models of learning provide us with insights into our instructional habits in higher education. Association theory supports the custom of professors repeating important concepts in their lectures and courses of study and giving students a series of problem sets to solve – practice makes perfect (Table 2). Association theory also explains the tendency to give frequent tests, based on the laws of effect and exercise, and why students are asked to recall facts or, in the case of multiple choice tests, recognize the best of several alternative answers. The limitation of associationist models lies in their tendency to promote rote rather than conceptual learning, that is, knowledge is construed as bits of information not necessarily related or contributing to a pattern or theory. The learner therefore adds to a storehouse of knowledge without necessarily linking it to other knowledge. Information theory introduces the processes of encoding, transforming and retrieving, and situates the student as an active participant. Constructivist theory suggests that students need to identify themselves as explorers or inventors who select and organize their own knowledge. This theory is more consistent with the methods of inquiry that different disciplines espouse.
How do these theories translate into optimizing student learning?

Table 2. Models of learning and implications for students

Learning as association/memory	Subject matter is impressed, retained, and recalled: *Student as storehouse of knowledge*
Learning as information processing	Information is encoded, transformed and retrieved: *Student as active knowledge processor*
Learning as constructed	Goal-oriented discovery of relationships between new and extant knowledge: *Student as explorer and inventor, selecting and organizing knowledge*

What Do Our Students Know About Learning?

We know that student preparation for learning and student goals have changed over the past 30 years. More entering students report experiencing stress; over the last decade, the percentage of students 'overwhelmed by everything they have to do' has risen from 16% to 29% (Astin, 1998). Astin also reports that financial well-being is a more important goal for American postsecondary students than developing a meaningful philosophy of life. Students thus tend to not be oriented to a scholarly life. Their orientations are reflected in the priority they assign to different activities – the way they spend their time. In a sample of over 500 students at my university, they told us that they spent an average of 13 hours per week on studying and homework, but almost as much time socializing with friends and partying (9 + 3 hours) (Donald & Dubuc, 1999). Other extra curricular activities took up less time (four hours in exercising or sports; three-to-four hours watching TV and hobbies). They spent less than one half hour a week talking with teachers outside of class, a pattern that is widespread in North America. Students may complain that they have little chance of encountering their professors, but they do not appear to take advantage of opportunities when they arise. We can infer from these findings that students' priorities are peer oriented rather than academic.

At the same time, our students tell us that they expect to progress on several fronts during their undergraduate years: In their ability to analyze, synthesize and think critically, in their basic communication skills; in independence in learning; in the ability to interact with others; and in clarity of educational and career goals (Donald & Denison, 2001). Table 3 shows significant increases (*) in the importance of these criteria from entry to graduation. Students consider a commitment to learning quite important at entry, and this does not change. Counterintuitively, they rate academic preparedness equally important on graduation and at entry to university. What is perhaps most encouraging is that they attach extreme importance to the ability to analyze, synthesize and think critically on graduation, although their rating is more modest at entry. They are clearly telling us that they expect to learn to think, and that it is highly important they graduate being able to do so.

Table 3. Students' ratings of the importance of criteria for student quality

Criterion	At Entry	On Graduation
Commitment to learning	4.25	4.26
General academic preparedness	4.10	4.14
Ability to analyze, synthesize, think critically	3.70	4.54*
Basic communication skills	3.62	4.40*
Independence in learning	3.78	4.32*
Ability to interact with others	3.60	4.30*
Clarity of educational and career goals	2.90	4.23*
Ability to get a job	3.00	4.53*

important (2.50 - 3.49), **quite important** (3.50 - 4.49), **extremely important** (≥4.50)

Given these findings, how can we help students learn? Attention at three levels is needed: the institution, students, and faculty. At the level of the institution, policies must be reconsidered to establish a supportive learning climate. These may include greater access to professors, a statement of the university's commitment to learning, and clear expectations of student responsibilities. Students need to become aware of their role and responsibilities as learners, but this must be explained and supported by university policies and practices. As faculty, we first need to consider what our conception of learning is and what consensus there is within our field as to the nature of learning. To do this, we need to discuss with our colleagues what learning should be about in our programs. Then we need to make clear to our students what our conception of learning, and particularly higher order learning or thinking, is in our discipline, and instruct and assess our students according to this conception.

What Instructional Strategies Will Help Students Learn to Think?

To optimize student learning, the role of the instructor must evolve from a limited but frequently prescribed model of transmission or presentation of information to that of a facilitator of learning. The general question we pose in the courses and workshops we provide for our faculty and graduate students is: *How can we help students to become responsible learners?* Our primary goal is for participants to understand useful models of higher order learning that are consistent with the framework of a course they are designing or redesigning, and the kinds of instructional and learning strategies needed to achieve this kind of learning.

We describe a variety of models, one of the most comprehensive being the working model of thinking processes developed at McGill University from the postsecondary literature and tested in different disciplines at research universities such as Stanford, Harvard, Cambridge and Monash (Donald, 2002). This model is a detailed set of examples consisting of 30 thinking processes that apply directly to courses at the postsecondary level. It also delineates inquiry models used in particular disciplines, for example, 'expertise' *(identify the context, select relevant information, evaluate results),* so that references can be made in the terms used by a specific discipline. Table 4 shows those thinking processes most frequently used across domains.

In our study of this model, we found that professors across disciplines considered certain thinking processes or strategies important; this suggests that there are thinking processes a student in any discipline will need to acquire, although the discipline will determine the specific characteristics of the process. Greatest agreement across disciplines was found in the importance professors attached to students' learning to *identify the context* and *state assumptions, in changing perspective,* and in *selecting relevant information, recognizing organizing principles and synthesis* (Table 4).

Table 4. Thinking processes used across postsecondary domains

A. Identify the context	Explain the situation, framework, underlying principles, facts.
B. State assumptions	Identify suppositions, postulates, or propositions assumed.
C. Select relevant information, elements, relations	Select information, concepts, relationships pertinent to the issue in question.
D. Recognize organizing principles; organize elements & relations	Identify methods, rules that organize knowledge. See how ideas fit together.
E. Analyze	Weigh, compare and contrast evidence. Match evidence to theory.
F. Synthesize	Combine facts, concepts or procedures, compose, interpret, integrate to develop an explanation or solution.
G. Change perspective	Alter viewpoint, perspective of facts or issues
H. Solve a problem	Apply facts, concepts or procedures to solve an actual problem.
I. Evaluate results	Identify strengths and weaknesses of findings, justify or reject an assumption.

Identifying the context may consist of processes as diverse as setting up a general framework for a problem, recognizing what kind of problem one is dealing with, finding where a framework fits the processes being studied, or recognizing the history of the period in which the text was written. Stating assumptions is critical to solving a problem, recognizing bias, perspective or the framework being applied, or considering the steps to be taken or individuals to be taken into account. The general importance of changing perspective is consistent with the need for a constructivist approach to knowledge, where in building one's own cognitive structure, students must be aware of alternative frameworks and their advantages and disadvantages.

All disciplines acknowledge that because of the abundance of information and phenomena, students must learn to select. Recognizing organizing principles is essential to understand the structure of a discipline. Synthesis results in laws in physics, while engineering professors approach synthesis as a pedagogical goal for their students, training them in design skills in team projects. In education, synthesis is important for bringing together the many components of the classroom situation. In English literature, despite multiplicity and paradox as hallmarks, the search for form is central.

These thinking processes originate in different conceptualizations of thinking, for example, identifying the context is the mark of the expert, while stating assumptions is a defining characteristic of critical thinking. Selection has been used to define intelligence (Sternberg, 1998), while analysis and synthesis are found in the problem solving literature. Changing perspective and evaluating results are found in several approaches to thinking – in expertise, problem solving, and critical thinking. The fact that professors from different disciplines agreed on the importance of these thinking processes suggests that they are foundational to postsecondary learning. What if professors across disciplines advised students that these were strategies they needed to learn whatever course of study they were pursuing? What if these processes were deliberately taught and assessed in each course?

To help our students achieve higher order learning, we need to take a constructivist approach in which learning is goal-oriented and consists of the discovery of relationships between new and extant knowledge, where the student is thought of as an explorer and inventor, selecting and organizing knowledge. This means that we must help our students to learn how to judge knowledge on the basis of evidence, think through problems, and integrate and apply knowledge. In order to do this, we need to examine the disciplinary inquiry strategies we are responsible for developing, and how students develop more general learning strategies. For example, a team of professors may be needed to develop an explanation of the major principles and tenets governing the field of study, to describe how knowledge is validated, and to show the gaps or paradoxes and therefore the areas requiring further research and discussion (Donald, 2000). We also need to consider how we will model the processes of inquiry in our disciplines and explain how theory is developed and tested.

To set the stage, we need to show students what it takes to succeed in the context of a course, for example, giving them a sense of the number of hours of study required and the kind of work required. Small group learning experiences such as seminars, tutorials or undergraduate research allow students to develop their exploratory skills. Learning tasks that improve attitudes to learning, for example, participation in class discussion, projects, or explaining material to another student can be included in any course at any level. What these benchmark practices demand of us as professors is course organization, which is the instructional dimension that has the highest correlation with student learning (Feldman, 1989; 1996). When we talk about prospects for supporting students' higher order learning, however, we find that professors become animated by the possibility of creating learning situations that are exciting and personally fulfilling. Although much groundwork may be needed to produce a constructivist curriculum, this innovative process can be enriching and rewarding.

Acknowledgments

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Breakout Session: Bringing New Learning Modalities to All Disciplines

Leader: Greg Bothun, Professor of Physics, University of Oregon
Recorder: Naomi Frandsen, Graduate Student, Department of English, Georgetown University

Presentation

This session focused on a set of technology tools designed to foster both a collaborative learning environment as well as an environment that immerses the students in exploration and discovery. These new learning modalities have been accelerated by the widespread penetration of wireless internet in the college classroom, which gives instructors the capability to use wireless appliances to engage their students in a range of activities. The session investigated how such wireless appliances can become integral to the way a class session is conducted in any discipline and how they may produce a real partnership between student and professor in the exploration of that discipline. Rather than asking our students to step back into the last century in order to attend class, we should instead leverage these new tools and technologies to create a new, more collaborative learning environment.

Technology allows students sitting in a classroom--whether a large lecture hall or a smaller class setting--to use handheld transmitters and/or wireless laptops to instantaneously and simultaneously respond, give input, or ask questions about the professor's presentation. The responses, questions, and input are then broadcast to the entire class, allowing a PowerPoint presentation, for example, to be changed and made more specific and instructive during the class. This technology introduces a new learning modality that can be used in all disciplines. Session leader Bothun demonstrated this new technology by giving all session participants a transmitter to use throughout the interactive presentation.

The chief benefit of this new technology is its capacity to incorporate student input immediately and to increase student engagement—both of which are difficult to achieve in most typical classroom settings. Although some students may abuse the capabilities of a wireless internet classroom (i.e. by checking their e-mail and surfing the Internet), the mode of student involvement the technology fosters

co-opts some of the traditional distractions, allowing students to IM their professor instead of their friends. Professors can also administer anonymous quizzes, allowing themselves and their students to immediately gauge class and individual comprehension. Since he began using this technology, session leader Bothun has found that the number of pertinent questions asked in his classes has increased substantially.

Currently, the two main obstacles to widespread use of this technology are faculty lack of familiarity with it and cost. Faculty, first, need to learn about the technology and the ways it can improve their teaching and student learning; then, they need to be trained to use the software and, equally important, to craft the right questions and restructure their curriculum and/or teaching styles to engage students in different ways. To put in more bluntly, faculty need to emerge from there lecture mode style of curriculum delivery into the real world of collaborative communication and problem solving. Students can't be told solutions to problems; they must engage with them. With respect to cost, although the technology has not been marketed yet, the amount required to implement such technology is reasonable for a school with a technology budget. The transmitters cost about $30 each, and a lecture hall could probably be outfitted for under $10,000.

Session leader Bothun distributed transmitters to all session participants. He then posed several questions about the present nature of higher education and asked participants to respond, using their transmitters. The questions and results follow:

(1) Over the last 50 years the basic structure of higher education has changed: 1—Not at all; 2— a little bit; 3—somewhat; 4—quite a bit; 5—dramatically. Results: the majority chose #3 or #4.

(2) Change over this time period is best measured by: 1—An increase in the diversity of degree programs being offered; 2—a change in student retention/graduation size; 3—a changing distribution of class sizes across the curriculum; 4—an improvement in teaching facilities (i.e. classrooms and buildings); 5—better prepared students entering society; 6—a change in the way we teach our courses across the curriculum; 7—a larger percentage of the operating budget devoted to instruction. Results: no consensus, although #1, #5, and #6 were the responses most frequently chosen.

(3) IT has failed to produce any transformative change in higher education primarily because: 1—IT is fundamentally incapable of producing transformation; 2—IT is not supported by the central administration at the level it needs to be to make a difference; 3—faculty are afraid of being displaced if they adopt it; 4—students don't like it; 5—faculty do not understand how to use it effectively to produce such change; 6—no one really wants change; 7—you're wrong; transformative change at my institution has occurred. Results: the majority chose #5.

(4) The principal benefit of IT in higher ed is 1—The facilitation of better lecture presentations through PowerPoint or other technologies; 2—digital lecture material can be archived for later review by students; 3—research products can be more easily incorporated into the course material; 4—the increase of communication between professor and student; 5—the ability to do better course management (Blackboard); 6—to allow material to be presented in new ways; 7—to promote better student engagement with the course or material; 8—facilitate or build a shared learning environment. Results: #7 received the most votes, followed closely by #8. If #7 actually happens, as the group maintained, do the modes of assessment (exams) need to be changed to reflect this different, better engagement?

(5) Participation in undergraduate research at my institution is limited by: 1—Lack of meaningful credits for students; 2—resistance of faculty to act as undergraduate research mentors; 3—lack of central administration support for a more formal program; 4—overall poor student ability to carry out research; 5—incentives to faculty to become more involved with undergraduate research; 6—wholesale failure to embrace undergraduate research as an enterprise equal in value to taking courses. Results: the majority chose #5 and #6. In light of this response, session leader Bothun suggested that structural changes need to be introduced in order to effect #6, including possibly substituting research credit for general education credits.

(6) The best catalyst for undergraduate research at my institution would be: 1—Aggressive engagement by the Library in training of students in how to do research; 2—a well supported formally structured program where students have to apply to get in and receive considerable credit toward degree (U Delaware model); 3—faculty release time from teaching to engage in research mentoring; 4—create a position of Dean for Undergraduate Research; 5—give incentives to departments to develop programs within their disciplines. Results: the majority chose #5.

(7) Collaborative learning: 1—Increases students' critical thinking skills; 2—encounters faculty resistance because their power fades; 3—won't work because students abhor group work; 4—is difficult because it requires traditional course content to be restructured; 5—gives an important skill set to the students; 6—is generally impeded by the structure or layout of our classrooms; 7—is the latest new age mantra, devoid of any real substance. Results: There was no consensus, but responses included #1, #4, and #5. Dr. Bothun indicated that his students had chosen #3.

(8) Students learn the material primarily from: 1—Face to face time with the instruction; 2—preparing for exams; 3—exercises that increase time on task; 4—reading or accessing other sources of information relevant to course; 5—discussing the material with one another; 6—googling for answers. Results: There was no consensus, but responses included #2, #3, and #5.

(9) On my campus, wireless coverage is: 1—Everywhere in all classrooms and buildings; 2—50% everywhere, 3—25% everywhere; 4—only in specialized locations; 5--practically non-existent. Responses: #1 and #4.

(10) Wireless laptop usage in classrooms: 1—Will soon become a huge distraction and should not be permitted in the lecture hall; 2—is no different than students in the back row reading the student newspaper; 3—is beneficial to the student as their note taking skills are improved; 4—potentially allows the students to better interact with the lecture material; 5—potentially allows for a new teaching and learning dynamic. Results: #5.

(11) Fifty years from now, the structure of higher education will: 1—Be virtually unchanged from now; 2—be slightly different from now; 3—completely different from now due to rapid technological change; 4—have evolved from in situ learning to a fully distributed learning environment; 5—have been replaced by commercial entities; 6—much different but in a very unpredictable way. Results: There was no consensus, but responses included #2, #3, and #6.

Following the question/response exercise with the new technology, session leader Bothun spoke about the various uses and advantages over many existing methods.

Currently, the main use of technology in the classroom is to give a PowerPoint presentation. PowerPoint presentations, however, create a one-way flow of knowledge, with the students as the passive recipients. Students who gain information through this mode of presentation may do well on their exams, but they learn little and the classroom atmosphere it fosters encourage low energy, memorization, and a

syllabus-driven class rather than a student-driven or discovery-driven class. Using videos of packed lecture halls, Dr. Bothun showed the state of disengagement and isolation among these students: they were in the dark and out of focus (a play on the PowerPoint situation more generally).

Through resource-based learning, the burden of learning is placed on students because it requires them to go through material themselves. Studying for exams becomes more difficult because the exams now consist of real problems that demand thinking rather than simply repeating memorized details. Students often complain that, in demanding students to go through the material on their own, instructors who use this approach have abandoned their role. A collaborative-learning environment however also fosters group problem-solving, trains students to work in teams, and encourages an active exchange of ideas within the classroom. This type of classroom enhances critical thinking and breaks down the traditional classroom hierarchy because teachers are no longer filling empty vessels, but are instead functioning as facilitators and motivators. Dr. Bothun described the collaborative classroom as analogous to a Star Trek episode in that in both a group of humans work together using computers to save the universe.

The cognitive rational for approaches to teaching that emphasize problem-solving and collaboration is that conflict or disagreement necessarily arises outside of the lecture setting; when disagreement occurs, students' social relationships and peer interactions lead to resolution of the agreement and to learning. Further, students with the greatest knowledge of the subject under study can function as "explainers" to help the others gain proficiency. Using technology to create a collaborative classroom also helps illuminate the biases and patterns of thinking among the students themselves. Professors become mediators as students learn to share authority and knowledge with their professors since they have a material way to influence the class content. The compromise is, of course, that professors have to be willing to give up full coverage of a body of knowledge. "Tearing up the syllabus" is one way to encourage a new way of thinking about teaching process rather than content.

At the start of a semester, Professor Bothun hires undergraduates who have taken his class previously to attend "incognito" to help the group dynamics become functional early enough in the semester for productive learning and interactions to take place. Without these student facilitators, teachers would spend much of their time developing teams. On a related note, network technology allows for asynchronous distributed learning groups, or long-distance classrooms.

There are some obstacles to this collaborative classroom. One is the inefficiency inherent in student group work, which makes it difficult to restructure large core classes using this new technology. Co-teaching an interdisciplinary class in a collaborative environment tends to work best because it undermines the traditional hierarchy model from the beginning. Currently, at the University of Oregon where Dr. Bothun teaches, and at other universities, the biggest obstacle to the collaborative classroom is convincing the university leaders to build special spaces for these types of classrooms. Ideally, these spaces would be open and furnished with tables that can accommodate four-to-five students. The tables would be placed in natural configurations around the classroom. There would be one laptop per group. On-hand technical support is vital to making this classroom successful. Creation of these spaces should be part of a more general re-thinking of spatial dynamics by university leaders, with an eye toward eliminating teaching environments where students are crowded together. Libraries are especially receptive to proposals for reconfiguring space.

Despite the obstacles, however, the measured gains are great. Faculty members find collaborative learning environments challenging and stimulating. With a reinvigorated faculty, curriculum can be delivered in new ways, and students can enjoy a sense of community and equality. Students are also able to synthesize material from different disciplines and exercise critical thinking. The current software environment of document sharing and publishing encourages this direction in teaching. As students engage in some form of producing and publishing a result, the computer becomes an input medium, and classes are driven by what students need and think rather than what the teacher imposes.

Session leader Bothun concluded his presentation by demonstrating various ways of using this new technology, including manipulating and identifying elements on maps, creating more complex problem sets, and comparing student reactions, This demonstration also showed how easily scalable this technology is to very large groups.

Discussion

Since the focus of the session was on the presentation and demonstration of the new technology, there was little time for discussion, aside from technical questions and questions and observations made by session participants as they responded to the questions.

Recommendations

For Individual Campuses

- If one of the goals of undergraduate participation research is to produce educated citizens, more venues and opportunities need to be identified, both within and outside the curriculum, to reach all students. Possible approaches include: promoting and expanding "research across the curriculum;" encouraging student-initiated research projects; and developing a "research ladder" of experiences by categorizing specific courses that explicitly provide general research skills and have "research" as a focus, and developing deeper, more intense research experiences, again within and outside the curriculum.
- Campuses should offer capstone research experiences, perhaps in interdisciplinary teams. Another strategy is to view the capstone experience as a form of service learning.
- University leaders should undertake major a study of the campus's teaching facilities and equipment with an eye toward creating spaces for new modes of teaching. The study should serve as a basis for future construction, re-construction, and renovation.

For The Reinvention Center

- The Reinvention Center and its constituents should encourage funding agencies such as the NSF to include among the evaluation criteria information on the impact of proposed research on the "infrastructure of science." One element might be to make inclusion of undergraduates as an integral part of the proposal review process.
- The Reinvention Center should continue to provide leadership in probing "why undergraduate research?" Universities need a clearer rationale for how to incorporate research and research-related experiences into their undergraduate education. Developing this rationale will require differentiating research experiences within disciplines, leading to development as a future professional within the discipline, from research as a part of "general education," leading to the development of an educated citizen.

Resources/References

Websites

1. The University of Oregon use of wireless technology classroom: http://cc.uoregon.edu/cnews/fall2003/wirelessuse.html
2. The Collaborative Research Model: Student Learning Teams in Undergraduate Research: http://tep.uoregon.edu/resources/crmodel/index.html

Breakout Session: Mapping Learning Principles to Knowledge Structures in the Natural and Behavioral Sciences

Leader: Kenneth Kotovsky, Professor of Psychology, Carnegie Mellon University
Recorder: Jarrod Moss, Graduate Student, Department of Psychology, Carnegie Mellon University

Presentation

The assumption underlying this session was that different disciplines organize and compile knowledge differently. The differences in the way disciplines structure knowledge leads to the development of different skills, and they affect students' educational goals. These representational differences have important pedagogical implications and present challenges and opportunities for students' educational experiences. Session leader Kotovsky's interest in this subject came from his own background as a cognitive psychologist who studies problem solving and the importance of problem representation, teaches a large introductory psychology course where students' access to and assimilation of psychological knowledge is a constant issue, and is currently working with Jarrod Moss, a doctoral student in Psychology, on expertise and representation issues in mechanical engineering. The session was structured so that it began with a discussion of how different disciplines represent their knowledge, with participants talking about their domains. It then moved to a consideration of the implications the way knowledge is structured have for student learning and involvement in research both within and across disciplines.

Discussion

The discussion focused for the most part on three domains-- biology, psychology, and, to a lesser degree, engineering-- and the different ways they organize their knowledge base or findings. It then considered the implications their different educational goals and knowledge organizations might have for educational practice and undergraduate research involvement.

Biologists in different fields talked about their domain at a variety of different levels. Molecular and cell biologists seek to determine the molecular basis of living systems. They seek to explain function as a consequence of molecular structure. Evolutionary biologists seek to determine how the whole organism impacts Darwinian fitness, and many of the processes they study are emergent and can not be reduced to a molecular basis. However, the molecular basis is still important in studying evolution, and evolution is important even at the cellular and molecular levels. There was agreement that biology operates on a number of different levels from molecules up to the evolution of living organisms. While all biologists have as a goal to foster understanding of living systems at the molecular level, there was also an acknowledgment that some emergent properties could not be studied at lower levels, or at least not at this time.

Within the domain of psychology, the discussion started with the sub-domain of psychophysics, which examines sensory experiences. Psychologists in this field describe their work as the study of very basic processes which are close to biological processes. Other areas of psychology, such as developmental and cognitive, have a higher level of abstraction. In psychology, knowledge is generally represented in terms of sets of empirical results with little theory tying the results together, though in some sub-areas, such as psychophysics, the area of study is closely tied to more of a physical biological basis. One difference this focus on empirical findings leads to between psychology and other domains is that literature in psychology seems to be read starting with the most recent literature and moving to the past, while in other domains the literature builds on itself and needs to be read from the past into the present.

Their knowledge structures have implications for the extent to which and how undergraduates can become involved in research in the various domains. In biology, for students to be actively involved in research, a certain level of background knowledge is needed. Although students can easily come into a lab and enter and analyze data, the data is meaningless without appropriate background knowledge. On the other hand, biology is very diverse, which is good for involving students since students may interact with faculty at different levels.

A historian noted that half of his students do not take any natural science classes, but that they would benefit from understanding research in history because it would help them to develop an appreciation of data and how to assess and analyze it. He commented that the general nature of data and analysis may be similar across different fields. One example he gave for involving students early in their education is to have them compile an oral history of their family. This exercise gives them experience collecting some data with which to work and analyzing it. This and similar activities could be integrated throughout the four year curriculum to help students develop critical thinking skills.

In psychology the structure of the literature and the focus on empirical findings makes it fairly easy for students to become involved in research since they can read a small set of papers and come up with an interesting research question. Their involvement can assume many forms ranging from running their own projects to contributing meaningfully to the conceptual development of an advisor's project. In addition, since psychology studies human behavior and thought, students often have an intuitive understanding of a number of the issues they may be reading about or their instructors may be positing. Even if these intuitions about behavior turn out to be wrong, the findings are accessible to students.

Within the domain of engineering, students to have acquire substantial knowledge before they can understand the underlying logic and conceptual scheme that drives a research project. Some students may contribute at a conceptual level, but students often become laborers who only see a piece of the project.

Engaging students in multidisciplinary research is particularly difficult because of the different ways knowledge is structured in different domains.

What are the goals of involving undergraduates in research and how difficult is it to involve students in the various domains? Several goals were mentioned: Teaching students to be critical consumers of information, teaching them how a given domain structures and constructs its knowledge, helping them understand the boundaries and limitations of current knowledge, and teaching them an appreciation and respect for the way in which knowledge is constructed.

There are many ways these goals can be achieved. Involving every student in a research project advised by a faculty member presents challenges both from the standpoint of not having enough faculty and some students not wanting to be involved. Thus while participation in research is one way to add value to a student's education, other methods exist. One strategy that was proposed is bringing research-like activities into the introductory courses in a domain. These activities would give students an idea of the importance of research-related skills in a variety of domains, and the students may be able to see commonalities across domains in the way research is conducted. Critical thinking should be brought into the lectures as well. Instructors should be encouraged to plan their teaching by using examples that help students make connections across disciplines. Emphasizing connections may facilitate knowledge transfer across domains as the students realize the commonalities that define the domains, such as the critical thinking skills involved in interpreting and evaluating evidence. Students should also learn that different domains have different ideas about what constitutes evidence so that they can appreciate other domains, while being able to evaluate different types of evidence. Undergraduate curricula could be structured differently in order to highlight the similarities of domains. The curriculum, for example, could consist of different areas of knowledge such as modeling, communication, and so on. Within the modeling sphere, for example, classes might include mathematics, statistics, and computational courses. This structure highlights the methods and similarities of different domains.

Recommendations

- Students may benefit from knowledge structures outside their domain of study. Learning about other structures may highlight deficiencies in their domain or strengthen their ability to think critically about areas of their own domain.
- Research-like activities should be incorporated early in the curriculum so that students begin to develop necessary critical thinking skills early in their education. In addition, these activities will give students taking introductory courses in different domains some exposure to the methodology and research skills of those domains.
- Research experiences could be structured in a ladder so that there is a progression of research experiences at different levels. The combination of these suggestions means that students will benefit from their domain courses as well from courses outside their domain.

Resources/References

Publication

Donald, Janet G. (2002) *Learning to Think: Disciplinary Perspectives.* San Francisco, CA: Jossey-Bass.

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Kotovsky/Powerpoint.pdf

Breakout Session: Bringing Instructional Innovations that Work in One Discipline to Other Disciplines

Leaders: Patricia J. Pukkila, Associate Professor of Biology and Director, Office of Undergraduate Research, and Martha S. Arnold, Director of Curriculum Development, Center for Teaching and Learning, University of North Carolina at Chapel Hill
Recorder: Danielle C. Glickman, Doctoral Student, School of Social Work, University of North Carolina at Chapel Hill

Presentation

Undergraduates in humanities and social science courses may not have ample opportunities to engage in original research and scholarship. In addition, it is often difficult for faculty in a particular discipline to discuss how teaching or course strategies that are successful in other disciplines can be modified and adapted productively. This session was designed to address both of these challenges by offering a flexible model that enables faculty in a wide range of disciplines to convert conventional course assignments into research projects by bringing advanced graduate students into the course for part of the semester to direct the projects. Session participants were then asked to consider how cross-campus adaptation of successful strategies can be encouraged.

Overview of Graduate Research Consultant (GRC) Program

The Graduate Research Consultant (GRC) program (http://www.unc.edu/depts/our/GRCprogram.html) is a new initiative at the University of North Carolina at Chapel Hill directed at humanities and social science faculty who teach undergraduate courses and would like to add a research dimension to their students' experience. The program is designed to encourage and assist these faculty to convert conventional course projects and assignments into research projects that are carried out by undergraduates within the course context. The approach is to help them to re-think their curriculum, with the goal either of modifying the way they teach certain aspects so that they become "research-based" projects that can be carried out by individuals or small groups of students in the class or, in cases where ready modification is not possible, to add a research component. A key feature of the GRC program is the involvement of graduate students, or Graduate Research Consultants (GRC), whose primary role is to assist the undergraduates as they plan, carry out and disseminate the results of their projects. The faculty member may choose to work with one or more graduate consultants. The graduate students are paid the standard UNC Teacher Assistant (TA) hourly rate for 30 hours of work throughout the semester. Initial funding for the GRC program came from the University's Office of Undergraduate Research and Center for Teaching and Learning. In 2003-2004, the first year the program was implemented, 19 faculty, 27 GRCs, and 650 students participated.

Collaboration and Inquiry in the GRC Program

The GRC program is a collaborative effort of the Office of Undergraduate Research, directed by session leader Pukkila, and the Center for Teaching and Learning, where session leader Arnold serves as Director of Curriculum Development. In developing the GRC, directors Pukkila and Arnold sought to create a model that is dynamic and flexible and readily adaptable across disciplines and perhaps other curricular contexts as well. The model emphasizes collaboration, ongoing inquiry, and support for experimentation and adaptation at every level. Underlying the process of collaborative development that gave rise to the program is the belief that multiple perspectives and the collective academic experiences of faculty yield rich ideas for changing courses and the classroom environment. The initial GRC program collaboration began at the institutional level with discussions between directors Pukkila and Arnold on how together they could support and encourage inquiry-based courses for undergraduates in social science and humanities disciplines. To broaden their thinking, they brought together faculty from social science departments to offer their perspectives on barriers and possibilities for undergraduate research within course settings. The idea to create the position of GRC, to collaborate with the faculty member in designing and implementing the course research components, emerged during the discussion. The GRC program is stronger

because of its collaborative origins and because of the formal connections and collaborations it has established with other units of the University, including the College of Arts and Sciences, curricular programs within the College such as First Year Seminars, the Academic Affairs libraries, and the Odum Institute for Research in the Social Sciences.

Collaboration throughout the development process was informed by a framework of inquiry in deliberate forms. These forms of inquiry included:

- Initial investigations with faculty to better understand the barriers and possibilities for research in undergraduate courses.
- A series of research questions that guided the pilot program from the beginning (e.g., Is the GRC adequate support to encourage faculty to provide these research opportunities within courses for students? What steps need to be taken and what needs to be built into the program for this collaborative model to work effectively for faculty, the GRCs, and the students?)
- A mid-year meeting in which participating faculty and GRCs reflected on their experiences in the program and teaching their revised course and the extent to which these experiences met their expectations and goals.
- A meeting with the directors of undergraduate studies to get their perspectives on the barriers and benefits of the GRC program for their individual departments.
- A qualitative, formative evaluation of the GRC program.

In addition to assisting faculty in developing and incorporating research activities into their courses, the GRC program also provides support for faculty experimentation and adaptation. The GRC program has been adapted both within courses and across disciplines. One way faculty have experimented with the GRC model is by working with GRCs whose department and/or discipline is different from their own. This arrangement enables the graduate students enrich the course by offering a second perspective on the course material and adding an interdisciplinary dimension. In addition, many of the GRCs have brought skills in research methods that complement those of the faculty member.

GRC Experience

Danielle Glickman, a doctoral student in Social Work, described her experience as a GRC in an introductory Communications class. The class research project was to administer a survey or conduct interviews on an aspect of communications behavior. Some students, for example, investigated gender differences in responses to an emotionally-charged image like a picture of the World Trade Center site on September 11. The students were expected to carry out all phases of the research, from formulating the research question to disseminating the results in two formats: A paper written in a journal-type format and a three-slide PowerPoint presentation summarizing their research question, methods, and results. All of the projects were conducted by groups made up of four-to-six students.

The class was comprised of approximately 160 undergraduate students, necessitating the use of four GRCs. All were doctoral students in UNC's School of Social Work. The Social Work students were recruited by the course instructor because the Communications Department had only a limited number of graduate students available to serve as GRCs. Because the GRCs were not knowledgeable in the course content, they were responsible only for helping the students with research methodology. If the students had content-related questions, they were instructed to approach the course teaching assistant or instructor.

All of the GRCs had weekly office hours during which they met with their groups of students to discuss their project. The groups were required to meet with their GRC at least once during the semester. The main role of the GRC was to assist the students, as needed, in any phase of the research process from helping them to formulate a research question and hypothesis, to advising them on requirements for obtaining informed consent, to guiding them in choosing the appropriate type of survey instrument and determining the sampling method to employ, to advising on methods of data analysis, to helping them to disseminate their results. After the initial meeting with the GRC, several of the groups set up follow-up meetings and/or corresponded via e-mail regarding additional questions they had about research methodology.

Evaluation of the GRC Program

A qualitative, formative evaluation of the GRC program was conducted in order to help both individual faculty and program planners assess and refine the course-based research experience for undergraduate students. All faculty and GRCs who participated in the nine courses involved in the program in the 2003-2004 academic year were interviewed about their experiences, as were subsets of students from the nine courses. A summary of the responses can be viewed on the "Frequently Asked Questions" page at http://www.unc.edu/depts/our/grcfaq.html. The major benefits cited by the three groups follow:

- Benefits from Faculty Perspective
  - The experience contributed to overall satisfaction in teaching the course.
  - The GRC was more knowledgeable than I in particular methodologies.
  - The addition of the GRC improved students' accomplishments.
  - The program contributed to the professional development of the GRC.
- Benefits from GRC Perspective
  - Advising the undergraduates helped me to conceptualize how research is conducted in a classroom setting.
  - The experience provided me with information on capabilities of undergraduate students.
  - The experience increased my confidence in helping students learn.
  - It helped me to become a better instructor in the future.
- Benefits from Student Perspective
  - I learned valuable skills in setting up a research project.
  - The interdisciplinary nature of small research groups was beneficial.
  - It was useful to apply lessons learned in class to the real world.
  - It was beneficial to learn statistical software.

Discussion

Participants in the session were asked to identify one issue on their campus they are currently trying to address. A variety of issues were mentioned:

- How to raise awareness among colleagues about problems with the current lecture system and coming up with alternative methods for delivering information to students
- Concern with graduate student professional development—how to provide resources to graduate students so they can develop their strengths, and also how to change the culture in their departments so that graduate student teaching is valued
- Adapting the success of liberal arts schools to research universities—how to scale up from class sizes at liberal arts

schools to larger universities
- The intersection between research and service learning
- How to integrate research into the classroom for a student who is not necessarily an honors student
- Trying to translate what works well in undergraduate research opportunities program into the classroom setting
- Getting faculty who want to incorporate research and research-related activities into their courses to conceive of ways to engage their students so that they see that, in addition to the discovery of knowledge, research also involves synthesis and application
- How to create awareness of undergraduate research at the institution/university level
- How to develop core classes that can be taken by students from multiple majors—how to come up with the curriculum and content in those courses so that they are applicable to students from different departments

Participants in this session also considered how the GRC program might be modified or adapted to facilitate and strengthen the integration of research into undergraduate education on their own campuses. Numerous suggestions were put forward:

- Campuses should broaden the definition of research beyond one-on-one mentoring in labs and incorporate some exposure to research in introductory courses by adding to the content of lectures, journal clubs in lab, or discussion sections.
- The GRC program could be applied to a Humanities and Social Sciences college (e.g., History and English) where research opportunities are not commonly available.
- Instructors of freshman level courses should create assignments that necessitate information retrieval and research-related skills like inquiry and critical thinking. This can be accomplished through projects that require students to use the rich library resources that are available on-line via library websites or in the library building.

There was a consensus that the GRC and similar programs have the potential to bring together and strengthen three interests that many research universities have: To involve graduate students in undergraduate research, to raise awareness of ways research and elements of research can be incorporated into classroom settings, and to ensure that all undergraduates have access to and take a class with a research component as a requirement for graduation.

Recommendations

For The Reinvention Center

- The Reinvention Center should conduct a study to determine how programs like the GRC program are modified when they are adopted across disciplines or between campuses.
- When the Reinvention Center publishes the Conference Proceedings, it should include an index.

Resources/References

Websites

1. The Graduate Research Consultant Program at The University of North Carolina at Chapel Hill: http://www.unc.edu/depts/our/GRCprogram.html; to read the responses to the 2003-2004 GRC participant interviews visit: http://www.unc.edu/depts/our/grcfaq.html
2. The Center for Teaching and Learning at The University of North Carolina at Chapel Hill: http://ctl.unc.edu/
3. The First Year Seminars Program at the University of North Carolina at Chapel Hill: http://www.unc.edu/fys/
4. The Odum Institute for Research in Social Science offers diverse services to support the research and training of social science faculty and graduate students. http://www2.irss.unc.edu/irss/home.asp

Breakout Session: Engaging and Retaining Targeted Populations

Leader: David Ferguson, Distinguished Service Professor of Technology and Society and Applied Mathematics and Chair, Department of Technology and Society, Stony Brook University
Recorder: Jeannie Brown Leonard, Research Assistant, Interdisciplinary Studies, University of Maryland

Presentation

The engagement and retention of targeted populations in science, technology, engineering, and mathematics (STEM) is a concern for many universities in the United States. Drawing mostly from work with under-represented minority groups and, to a lesser degree, with women, session leader Ferguson offered his perspective on strategies for increasing participation by both groups. His introductory remarks were based on observations he made in 2004 in the Archie Lacey Presentation he gave to the Science Education Section of the New York Academy (http://www.nyas.org/ebriefreps/main.asp?intEbriefID=262). The presentation described his 20-year history of promoting diversity in STEM at the University at Stony Brook. A copy of his remarks was distributed to session participants.

Reversing the gross underrepresentation of minority members and women pursuing STEM disciplines at the graduate and undergraduate levels will require a significant change in the way higher education conceives of and delivers its STEM education. Yet such change is essential. It is motivated by three factors:

1) U.S. workforce needs. Higher education needs to prepare more students to meet the technological workforce needs of our country. The decline of U,S. citizens interested and pursuing advanced education in a science or engineering field is a serious problem.
2) Science and engineering reflects the image of its creators. Meeting the needs and interests of the U.S.'s increasingly diverse population requires redefining what we do, the products we develop, and the culture of STEM itself. If different people do science and engineering, will we get a different science?
3) The inherent value of diversity. We need to have more underrepresented students in our programs in order to achieve greater equity and fairness.

Higher education is undergoing a paradigm shift from being teacher-centered to learner- centered. In the late 1970s, Uri Treisman, then an instructor of mathematics at the University of California-Berkeley, did pioneering work on the underperformance of African American and Latino students, particularly in calculus. Since these students had been accepted at Berkeley, which is highly competitive, they clearly had some academic ability, yet they were failing calculus. Treisman created study groups that focused on complex problem solving, and he provided a supportive social environment. His intervention led to increased engagement in calculus and improved performance and was an early example of the impact a learner-centered environment can have on student learning.

There are two key challenges that must be addressed if higher education is to create learner-centered environments supportive of students from underrepresented groups:

1) Issues of access and success for underrepresented students within the existing system;
2) Removing systemic barriers. Rather than trying to help students fit into an existing system, we need to probe and interrogate that system so it is more receptive to people of difference.

Organizations are notoriously slow moving and static, but we cannot wait for an institution to change to create more complete access for underrepresented groups. Instead, we ourselves—faculty, administrative leaders and professional staff—must take the lead in building a community of science and engineering scholars made up of students from underrepresented groups—while recognizing that building communities to promote success in the existing environment is a daunting challenge.

One strategy that has proved effective is for universities to connect with high school population—to identify and recruit prospective students while they are still in high school and then work with them from their first year at the university through graduation. It is critical for students to do well in their foundational courses. Within our own institutional contexts, we need to know the minority students who are enrolled in our foundation courses and have mechanisms for keeping track of their performance. Creating effective communities and interventions to improve the chances of their success are vital. One intervention, for example, might be to establish separate sections within foundation courses with study groups. Another is to introduce research experiences early in the undergraduate curriculum. Women in Engineering programs do this well. Our goal should be to form a community that engages underrepresented students and allows them to take advantage of university resources. Communities can either isolate or empower. In higher education, communities need to be empowering.

At the University at Stony Brook, the minority student experience in STEM fields twenty years ago was fragmented and alienating, with the students rarely having the opportunity to get to know one another. This started to change when a small group took the lead in establishing a local chapter of the Society of Black Engineers (NSBE). For this group, attending their first national meeting of NSBE was a "religious experience" that had a profound impact. The students were amazed by the wider community of Black engineers they encountered and were surprised by the strong presence of Black students in the field. Their experience reinforces the importance of community and of engaging the resources of the institution. Many students need our help in making these connections. It is not surprising that a few years after the NSBE chapter was formed, noting its benefits, a group of Hispanic students decided to establish a local chapter of the Society of Hispanic Professional Engineers (SHPE).

Recruitment efforts are intended to build linkages and relationships with middle and high schools and other colleges. Community colleges can be an important source of transfer students. Universities need to invest in local schools so that their students can see that enrolling at your institution is possible. Stony Brook is involved in a middle school project that serves a large population of minority families on Long Island. Though this community is only 40 minutes away from Stony Brook, before the project was initiated, none of its families had visited the campus or knew about the University. This insularity of communities reinforces negative expectations. Higher education needs to build a community of minority math and science scholars on our campuses who interact with these regional students.

With support from the NSF, Stony Brook established the Research Careers for Minority Scholars (RCMS) program, which had a remarkable impact on Stony Brook's efforts to recruit and retain members of targeted populations in mathematics. About 12-15% of the students in Stony Brook's mathematics department are now from underrepresented groups, and this figure is approaching 18%, which is the level of representation of minority students at the University. Once students are on campus, the University must offer a community to support them. Community building efforts are now being applied at the graduate level. At Stony Brook, there currently are about 70 underrepresented students in STEM graduate programs—an embarrassingly low number. Graduate students need community building as much as do undergraduates—especially since some departments have as few as one or two minority students.

From a systems perspective, our institutions are at different places in trying to influence the success of all students. In an effort to create academic communities for all first-year students, Stony Brook just established undergraduate colleges in which students engage in topics of interest with senior faculty members from the beginning of their college career. Other universities have similar colleges. Efforts like these are important systemic approaches to building and sustaining community, which in turn affects retention and success.

Discussion

Session leader Ferguson initiated the discussion by posing three questions: Where are you coming from? What issues are you facing? What strategies are you using? The responses and observations of the participants fall into several broad categories: The role parents and family play, making research appealing to minority populations, academic preparedness, the role of faculty mentors, on-campus support, academic pipeline issues, and concerns about affirmative action.

The Role of Parents and Family

Despite strong campus programs dedicated to easing their transition to college and providing academic support, for many minority students, the pull of the cultural and family community away from higher education can be strong and lead to attrition in the second year. When universities build a successful community on campus, the community typically does not involve the students' parents or family nor take into account its influence. One approach to this problem is to educate parents and families along with high school students, teachers, and counselors. Invite parents to attend bridge programs to discuss the ways they can support their sons and daughters. Often, for example, other than a career in medicine, lower income parents are unaware of the range or abundance of jobs that will be available to students who major in STEM fields; thus they may discourage their children's interest in mathematics. Faculty and staff need to be present and support students as they wrestle with the conflict posed by the lack of congruency between their own aspirations and the expectations of their family. We do not solve the problems for students, but we can help students think through their options. Family expectations are powerful forces that shape students' experiences. Higher education can do a better job of partnering with families and communities.

Making Research Appealing

Many minority students who start in STEM fields do so because they are interested in going on to medical school. Frequently, if their performance in foundational courses is disappointing, they abandon their medical school ambition and, rather than persist in a STEM major, change their course of study or leave the university altogether. They do not view participating in undergraduate research as a necessary or desirable element in their education since they not only do not recognize

the link between research and medicine, but they do not see the link between research and any career. Recognizing the potential a research experience has to teach them important skills and perhaps open them up to new educational and career possibilities is an important step. Whether or not the student's eventual goal is medicine, a research-based curriculum prepares students for more than just research careers; there are benefits to inquiry-based learning. There is a need for minority candidates in the pre-medicine program too, but helping students to make informed choices rather than defaulting to medicine as the only recognized outlet for a science interest serves the student and the institution. By partnering with high schools, a university can host programs for students, teachers, parents, and counselors to showcase what mathematicians, engineers, and research scientists do. Bringing students to campus and conducting lab demonstrations also can help. Summer institutes or workshops offer another model. For students already enrolled in our institutions, faculty can be influential in pointing them to graduate school. It is important to plant the seed of advanced education early and to provide students with opportunities to explore their interests.

One participant noted that African American students who attend historically black colleges (HBCUs) that have strong research programs are more inclined to participate in undergraduate research than their counterparts who are at predominantly white institutions. This makes sense in that HBCUs have a community of African American students. If a student is the only African American in a class or in a major, she or he is more likely to retreat intellectually. The energy needed to develop connections with African American peers at predominately white institutions takes priority over intellectual engagement. The University of Michigan has been collecting data on minority undergraduates that links participation in research experience with retention.

Academic Preparedness

Many students from underrepresented groups, even those who graduate first in their high school class, come to the university unprepared (not even underprepared). As a result, these students typically need more than four years to graduate because they must take preparatory classes before they take the basic foundation courses all science curriculums require. The chair of biology at one institution has addressed this problem by incorporating the remediation students need in the regular introductory course. Undergraduate research is part of this package. It offers two benefits: First, the experience of doing science diverts some students away from medicine in favor of further education and a career in a STEM field. More importantly, the model allows students to be successful in their studies. Lamenting the poor preparation in the K-12 educational system without offering remedies does not serve students currently enrolled on our campuses.

Not all departments have chairs willing to modify the curriculum. At another institution, the sciences have a reputation for weeding out students in their introductory courses. Grading is exceptionally strenuous, and it is not surprising for a self-described science student to earn a C+ in "Introductory Chemistry" and an A in English. These grades prompt many students to change majors to English. To retain underrepresented students in STEM fields, it is important to improve the success rate in introductory science courses. At one institution, there is a 50% failure rate in these courses—for all students, not just students from underrepresented groups. While the need for interventions to support students is apparent, departments are not always cooperative. Their reasoning is clear: If more students were successful, the departments could not handle the demand that would be placed on their upper division courses. In such cases, the institution has to set priorities and offer resources to serve students better. Campus leaders will need data to inform decisions. One approach is to track students in the introductory courses to illustrate the problem to deans and provosts.

Several possible interventions were suggested. They include: Integrating remediation into the introductory courses, offering additional recitation sessions, increasing mentoring by faculty, and building a community of scholars who will provide academic and social support to minority undergraduates. Undergraduate research also shows promise as a means of getting students connected to a faculty member and exposing them to science in a discovery context. Rather than approach this problem with a deficit model in which the student is viewed as lacking something, departments and university leaders need to consider ways of changing the system or the courses that have such dismal success rates. Some universities have changed the curriculum, moving away from the hazing approach to teaching to a more collaborative orientation. These institutions also are making the curriculum more relevant to students.

Faculty Mentors

The underperformance of underrepresented groups in the sciences may well be related to the academic culture of STEM fields. All students, but particularly students from underrepresented groups, need to connect with faculty in their major department. For students from underrepresented groups, establishing this connection can be complicated by the fact that there are very few faculty who look like them. White faculty can serve a mentoring role. However, all faculty, regardless of racial/ethnic background, need guidance on how to reach out to these students. Poor performance is linked to the curriculum and to the climate. Students need validation!

Rather than subscribe to a "survival of the fittest" approach to the foundational courses, universities need to support efforts to ensure students can master the academic content and feel connected to the university. Even capable students are less likely to persist in an unwelcoming environment. Dropping out of science courses and majors may lead to dropping out of college. Retaining all students on our campuses must be an important priority, regardless of the major they eventually complete.

Every faculty member has the potential to make a difference in a student's life. Faculty need to do what they can in support of minority students. A participant in the session described how bringing a student of color to an admission program for high ability students to discuss her research experience had a ripple effect. Students of color who had not attended this event heard about the presentation and sought out this faculty member for assistance. Still, departments need to make a commitment to hiring faculty of color. The power linked to representation is great, but faculty from underrepresented groups should not be expected to mentor all students from similar groups. Again, the commitment needs to be institution-wide. Students quickly learn who among the faculty members they can trust and the word will spread. Women in engineering programs are models of success in this area. They are able to engage women students, even though there are very few women faculty teaching in engineering programs.

The psychology department at one university initiated a mentor program for minority students to encourage them to pursue graduate study. The program includes a research component, which is linked to the introductory psychology course. This early exposure to research has primed students for publishing and conference presentations. Between 40% and 50% of the students who participate in the program now pursue graduate school, and undergraduate enrollment in it has grown considerably.

Through undergraduate research, students connect with faculty and discover options for their future. Involving students, especially first-year students, in research is challenging for faculty. Faculty resist because they do not think first-year students bring sufficient academic background or skills to their work. Yet, these students can follow instructions and respond to training. Once given a chance, faculty discover, students can contribute. It takes faculty who are willing to take a risk for the partnership to work.

On-Campus Support

Models of support that require students to take the initiative may disadvantage students from underrepresented groups. Campus services and faculty mentors need to reach out to students. At one university, the Office of Undergraduate Research facilitates this outreach effort by connecting students to undergraduate research opportunities. This campus recognizes that faculty are researchers first and mentors second and that faculty are often not skilled at initiating relationships.

Creating a community of scholars is another fundamental way universities can support students. Universities should establish mechanisms that help student of color in STEM majors find one another so that the experience of our campuses becomes less isolating and the students feel a greater sense of empowerment. Programs, departments and/or university-wide offices should sponsor student organizations that serve specific populations and facilitate the formation of study groups to enhance academic performance.

Career and academic advising support can also help students succeed. When does it make sense to persist in a STEM field and when is it better to choose a different academic path? Faculty advisors may need some guidance on these matters so that they can serve students better. Once students are on campus, support systems must be in place to help them to graduate. For some that support means academic interventions, for others it means guiding students to another major. Unfortunately, dropping out is a common outcome for students who are demoralized by poor grades in their chosen field.

Academic Pipeline

Issues of access to institutions of higher education for students from underrepresented groups continue to be a challenge. Yet, even those students who do enroll are not graduating at high rates. Low retention rates affect the pipeline within STEM. Efforts designed to encourage minority students persisting to graduation to pursue advanced degrees are crucial. When more students from underrepresented groups continue on to graduate school, the pool of prospective faculty of color to join our departments increases. Again, connecting students to research opportunities breeds excitement and propels students to graduate school.

It is difficult for higher education to correct problems that are systemic in the K-12 system of public education. By emphasizing memorization over deep thinking, teachers are setting expectations too low. The picture is grim when you consider that most K-12 school teachers do not believe that all students--not only minority members—can learn to a high standard. The effort to reorient students to a more engaging academic experience needs to happen early; it needs to happen in pre-school.

There are 34 colleges participating in the Mellon Minority Fellowship Program. This program is no longer expanding, but the benefits of the initial effort are great. The program supports talented minority students who intend to earn a PhD in a field supported by the Mellon Foundation. So far, the program has produced 150 PhDs across the nation. All Fellows are assigned to a faculty mentor and receive funding for summer research between their junior and senior year. They also have regular meetings to discuss graduate school, and they have opportunities to meet with Fellows attending other schools to share their research. This program is contributing to the number of minority students pursuing advanced degrees. The Turner Fellowship program at Stony Brook also supports minority students pursing their doctorates. Campuses interested in expanding the number of faculty from underrepresented groups might consider tapping these resources for future faculty searches.

Affirmative Action

The state of California has eliminated affirmative action programs in public college admission, an action that has led to a large drop on most campuses in the number of students from underrepresented groups applying and matriculating. This decline in students of color affects all academic programs by feeding and exacerbating a cycle of fewer graduates of color, fewer graduate students of color, and fewer faculty of color. In contrast, there is an overrepresentation of minority members in our prisons. This systemic problem is troubling. Some institutions in the University of California system have sought private funding to creatively circumvent the state policy. Outreach efforts to high school are among the few ways individual campuses can affect enrollments. Of course, many of these programs have lost their funding or are at risk of losing their funding in the current budget climate.

The challenges are great, but the potential for influencing change also is great. The important first step is to start doing something. At our institutions, assessing the current status takes time and energy. Yet, with data, change agents can rally support for important initiatives. The early efforts are very difficult, but over time a community of students will grow, as will a community of faculty and staff allies. Undergraduate research is a promising means of creating community and connecting students to faculty, two outcomes that positively influence retention.

Recommendations

- STEM departments by themselves and in collaboration with campus-wide offices such as the Office for Undergraduate Research, should make a concerted effort to connect students from underrepresented groups to faculty via undergraduate research early in their college careers.
- Academic leaders and administrative leaders with responsibility for students affairs and support serves should work together to create and support mechanisms to help students from underrepresented groups connect with one other. Establishing communities of scholars is central to retention and success.
- To address issues of minority student access to our institutions, and our STEM programs in particular, universities should form partnerships with high schools, two-year colleges and local community groups. Families should be included in these efforts.

Resources/References

Websites

1. Archie Lacey Presentation given by David Ferguson at the New York Academy of Science: http://www.nyas.org/ebriefreps/main.asp?intEbriefID=262.
2. The National Society of Black Engineers: http://nsbe.org/
3. The State University of New York Louis Stokes Alliance for Minority Participation (SUNY LSAMP), an organization working to change the basic shape of STEM education and forge new opportunities for underrepresented minority students in New York State:

http://ws.cc.stonybrook.edu/sunylsamp/index.htm. For a comprehensive list of funding sources for minority scholars in STEM fields, click on the "For Faculty and Staff" icon.

4. Mellon Minority Undergraduate Fellowship Program: http://www.mmuf.org/.
5. Turner Underrepresented Graduate Fellowship Program at Stony Brook University: http://www.grad.sunysb.edu/turner/index.html

Breakout Session: Applying Principles of Learning in the Performing and Fine Arts

Leaders: David Hertz, Professor of Comparative Literature, and Giancarlo Maiorino, Professor of Comparative Literature and Director, Center for Comparative Arts Studies, Indiana University, Bloomington
Recorder: Anthony Lichi, Graduate Student, Department of English, Indiana University, Bloomington

Presentation

The theme of this session was making connections between humanistic study and the cultural life of the arts. Participants considered: 1) How to combine humanistic scholarship with the arts in the classroom, and 2) how to use resources such as art museums, concert halls, public sculpture and architectural sites to reinforce and strengthen the classroom experience. The session used examples of courses that connect literature and music and literature and art produced in a particular period to illustrate how, by exploring the historical, cultural, and aesthetic relationships of the period, these courses enable students to gain deepened knowledge of their own field by placing it in a larger context, and to engage the combination in genuine scholarly or creative activity. The session also considered strategies for helping students develop the interdisciplinary perspective necessary for understanding the relationships.

Part One

The first part of the presentation was devoted to music and in particular to two courses developed by session leader Hertz to enhance students' understanding and appreciation of music as an art form shaped as much by cultural, aesthetic, and historical forces as by the composer's own creativity. Professor Hertz was motivated to develop these courses by the current crises in the arts and his conviction on "How the Humanities can Help Save Classical Music." (See the paper that follows this summary.) Two indicative signs of the crises, he noted, are, first, the enormous deficits facing orchestras around the country due to increasingly smaller audiences, and, second, a recent NEA report "Reading at Risk: A Survey of Literary Reading in America," that highlights how people are reading less and reading books of lower quality. Professor Hertz pointed to the digital culture in which we live as one of the primary causes for this crisis in the arts because it provides people with quick and easy sources of information and communication. Another cause he suggested, and one that is particularly relevant to this conference, is the tendency academia has to preoccupy itself with abstract, theoretical language, which becomes an obstacle to undergraduates and those not specialized in an academic field. The modern university, one of the great achievements of our culture, with its abundance of resources, is one place where countermeasures can be taken to address this crisis.

To illustrate this point, Professor Hertz described two courses he has taught—"Debussy and His Era" and "Beethoven and His Era"—in which he tries to increase the literacy of his students so that they may better appreciate what they hear. In both courses, his approach is to contextualize the work of the composer by bringing in the art and visual imagery of the period, as well as readings from other disciplines, such as Hegelian philosophy for Beethoven, a point he illustrated by playing some music for the attendees. He also attempts to make the personal experience of the artist more alive by emphasizing the "drama of the composer's life story" through letters and other biographical sources. All of his students are required to attend music festivals and concerts. This requirement serves several purposes. It not only enables students to have the visceral experience of hearing works they have studied in class, but it simultaneously stimulates and reinforces their understanding of the works and the artists and the times. Professor Hertz underscored the importance of students' having such experiences that confirm the connection between the cultural life of the arts and classroom study.

Professor Hertz urged a better coordination of resources in undergraduate education so that study in the classroom is informed and enlivened by cultural practices. Cultural practices, in turn, should be supported by humanistic study, extensive reading in biography and cultural history, teaching simple tools of analysis, scholarly activity, exploratory research papers and projects, discussion, review, and everything else that can done in the humanities classroom to stimulate students. In general, classes should be coordinated with cultural events on a continuous basis and on a much larger scale than Professor Hertz has been able to do or that is commonly done on most university campuses.

Another strategy is to develop programs on our campuses, similar to the one Leon Botstein initiated at Bard College, in which performers and scholars meet for an extended period of time. These clustered activities can engage students as well as communities.

Finally, we need to rid our sense of academic snobbery and pass on the best accomplishments in the arts to the next generation.

Part Two

The second part of the presentation focused on art as session leader Maiorino described his experience teaching comparative arts courses that combine literature and art. He began by outlining the basic principles of comparative arts, using the same approach and making the same comparisons as he does in his course "Modern Literature and the Other Arts"—which is the oldest inter-arts course in the country, first developed by professors at Indiana University some 50 years ago. He uses the example of comparative literature to make his argument for comparative arts study. Comparative literature as a mode of study allows students to gain a broader understanding of a given period, for example, following the path of Romanticism from Germany to England. Comparative arts provides an even more holistic view by emphasizing the extent and ways in which ideas move across the arts and how the arts themselves reflect underlying historical, cultural, and aesthetic crosscurrents. During the Renaissance, for example, the rebirth of the arts preceded a rebirth in literature. Thus comparative arts studies offers undergraduates the opportunity to gain an organic view of intellectual history.

To exemplify the relationship between literature and art and the range of questions that might be studied, Professor Maiorino used as his starting points the writings of Lazarillo de Tormes and Velasquez's painting "The Water-Seller." He described both similarities and differences between the two, which demonstrate the life of the "picaro" or underdog in Renaissance society. He suggested that students might probe such questions as, Why do we compare literature and the arts? Is it smart or is it necessary? Both of these works have poor characters. What are the similarities and what are the differences in the way they are depicted as a result of their medium? Why is it important to compare poor

characters? How important are poor characters in the art of the Renaissance? When do humble characters appear in literature and the arts? Why do we compare? What do we compare? How do we compare? Comparative study of their depictions points to different aspects of the Renaissance, one "humanistic" and the other the "anti-humanistic." Such comparisons can help students to solidify the conceptualization of cultural phenomena.

Just as the "high" Renaissance of the Sistine Chapel ceiling, for example, diverts viewers from the everyday reality of life in the streets, in academia, humanists often become practitioners of "high" "humanistic" study, to our own detriment because it we direct our teaching to the minority rather than the majority. We ought to do the reverse by building cultural literacy from the bottom up, by meeting undergraduates where they are, not where they ought to be.

Discussion

The group discussion focused on several issues raised in the presentations. Some questions were concerned with how to implement research in the classroom. How can research papers be incorporated into the course so that they simultaneously build upon classroom and cultural experiences and take students to the next step? How can projects be formulated so that they foster the integrative interdisciplinary learning both session leaders advocate? Another set of questions addressed "low" or "popular culture" versus "high culture." Should we "meet students where they are at" by using films, video games, rap lyrics, and other forms with which they are familiar and comfortable in our teaching? A third group of questions centered on practical ways in which we can promote student attendance at concerts, visitations to museums and other cultural practices. One attendee noted that we ought to include dance among these cultural practices, a suggestion embraced by the presenters.

Recommendations

For Individual Campuses

- Create strategies to promote a more vital cultural practice. Professor Hertz stressed the point that we should combine cultural practice with our undergraduate teaching. As a model, he teaches music history in the humanities classroom, takes students to concerts and explains the material in the course. Professor Maiorino added that our goal ought to be to expose students to the arts and encourage them to develop a frame of mind that allows them to appreciate and take advantage of the visual culture around them.
- Develop educational strategies that apply contemporary contexts and critical thinking to the creative process. Both professors believe we should reconsider the assumption that having students research and enter into academic "conversations" is the primary way to recuperate the humanities. Exploratory research is valuable, but more important is the need to dynamically expose students to the cultural resources that the university offers, resources that will enliven the reading, research, and analysis undertaken in the classroom. As Professor Hertz wrote, "[i]f cultural conditioning is necessary, let's give it to our young people and find a way to usher them into this *culturally* rich world, a world that offers lifelong pleasure, solace and the best of company."

For The Reinvention Center

- Lead an effort to redefine and achieve consensus on what constitutes "research" in the arts and humanities.

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How the Humanities Can Help Save Classical Music

David Hertz, Professor of Comparative Literature

There is a crisis in the arts and humanities today. The crisis is particularly well exemplified by the condition of the country's major orchestras, saddled with multi-million dollar debt, threatened by empty concert halls and mounting costs, under increasing financial pressure. The situation gets worse every year as the older audiences slowly disappear. The lack of the importance of reading in our culture threatens the livelihood of every writer and publisher. The recent NEA report on reading in the US, entitled "Reading at Risk: A Survey of Literary Reading in America," shows that readers are reading less today, and they are even less likely to read literature (poems, dramas, novels, or literary non-fiction). Why is this happening? Why are we failing? Where is the future audience for music, the reader for serious literature? Of course, the internet, email and multi-channel television in the new information era of the twenty-first century are some of the causes. These are quick, easy sources of information and communication. Can they replace the contemplative encounter with another mind, a great mind, that comes from reading? I don't think so.

One place where important countermeasures can be taken is the modern university, one of the great achievements of our culture. We need to make better use of our considerable resources in the university. In many cases we have failed because we have become preoccupied with abstruse language and here I join with Gerald Graf in saying that aca-

demic writing would improve if "professors had to explain" their "research to the undergraduates."

My recent experiments in the classroom over the past few years have been designed to address some of these issues. I have operated on a small scale as a humanities professor at a school (Indiana University) with considerable resources available to any interested academic, but I am looking for help and collaboration. I would like to reach a larger audience, to see more activity on a wider scale, to see others implement their own ideas in addressing the problems I am discussing today.

Over the last two years I have offered two new courses in the IU Honors College, "Debussy and his Era" and "Beethoven and his Era," designed to contextualize and open up the experience of great music for the students. The classes have been taught in conjunction with a festival and/or required attendance at a variety of smaller concerts, sustained over a fourteen-week period. Students have also studied the art and visual imagery of the era in which each composer worked and they have been prodded to attend the university art museum. In each case, readings were introduced from pertinent poetry and philosophy. I have turned to the life story of the composer to make the personal experience of the artist more alive for the students. In each case, I have selected the most literate and clearly written biography of the composer and assigned that to the students. If there are published letters, I assign them too. I also assign a variety of interdisciplinary writings about the composer and the era. The drama of the life story becomes more intriguing as we come to know the music. It also gives students who have less technical training another way to investigate and contribute to the overall learning. After all, every life has a shape--a beginning, a middle, and an end. And many cultural factors intersect in the shaping of a single life. Why not begin with something simple and branch out from there?

All performances and outside events have been contextualized in the classroom, sometimes with detailed analysis. The idea is to connect the cultural life of the arts with the classroom study. The visceral experience of music also enlivens the classroom. In the case of Beethoven, the Hegelian dialectic and synthesis of the sonata is immediately apparent. I say Hegelian because Hegel (1770-1831) was born in the same year as Beethoven, wrote profoundly about music, and was famous for his theories of thesis, antithesis and synthesis. Beethoven was more well-read in literature and philosophy than most people know. And he copied out statements from contemporary philosophers for contemplation (one from Kant in his letters, one from Schiller under the glass on his writing desk). Beethoven was a master at setting out contrasting themes in his sonata forms and bringing them together in a remarkable synthesis. We can just as easily speak about the Beethovenian dialectic as the Hegelian, or perhaps we should call Hegel's dialectic Beethovenian. Within the single movement of Beethoven's sonata forms, elemental and simple musical ideas are introduced, then set apart, brought together in imaginative synthesis and then reconfigured for a final summation. It has been a great pleasure to have the time to go through the tremendous varieties of musical experience to be found in Beethoven's thirty-two piano sonatas (most of which I play myself in excerpts for the students) and show the diversity of this musical enterprise to my students.

I have found that it has been well worth reestablishing links between important textual materials and the musical art works. This does not usually happen in the music history class as much as it could and there is no time for it in the concert hall. For example, Beethoven's charming letter to Julia Guicciardi should be read in the direct context of a performance (be it live or a recording), of the *"Moonlight" Sonata* (op. 27, no. 2), which is dedicated to her. In another letter, Beethoven complains that his grand Sonata in E flat major (Op. 81a) should not be called *"Les Adieux,"* but instead, *"Das Lebewohl."* The words *Das Lebewohl* are clearly inscribed in the authoritative Schenker score, directly connecting words, notes and the expression of departure and loss in musical sound.

Debussy, a rebel from a later period, turned away from Germanic structure. He particularly complained, with sarcastic humor, about the repetitiousness of Beethovenian musical structure (particularly development), and opened up western music to the sounds of Asia. We know Debussy attended the World Exhibition at the Champs de Mars in Paris in 1889. He heard Javanese music. After that his sound changed. This was the World's Fair for which the Eiffel Tower was erected. It was music written for a different time and different culture, the birth of the modern era, and it is not surprising to find that it has a different stylistic basis from the ground up.

All of these things take time to introduce, to teach, to explain, to discuss. But there is more than enough time within the framework of the humanities class. The coordination of music in the humanities classroom with the contextualized encounter with it outside class and in the concert hall is an important way to introduce students to a life of exploration and pleasure and an important way to cultivate tomorrow's audiences.

Last year I taught a music student who thought Debussy composed during the French revolution. This year I have a bright business student who had never, not even once, entered the Musical Arts Center, our university opera house, until I dragged my whole class there to hear Peter Serkin. The student later thanked me.

Another class to mention is my opera and literature class. I've had some rewarding success there over the years, but that is partly because of Indiana University's vast infrastructure for the study of opera. I require attendance at the university opera productions as part of the coursework. I've been amused to see my students well prepared for a night at the opera, well-scrubbed, dressed up, and with a date. And on occasion I've seen their parents who thanked me for forcing my students to go the opera. This happened after weeks of cultural conditioning in class intended to prepare for a meaningful experience. That means reading the novel or play on which an opera is based. For example, reading Prosper Merimée's *Carmen* serves as a wonderful preparation for Bizet's *Carmen*, as does Tirso di Molina's *Burlador di Sevilla* for Mozart's *Don Giovanni*, and Dumas fils's *La Dame aux camilles* (Lady of the Camilias) for Verdi's *La Traviata*, or Büchner's powerful early nineteenth-century play, *Woyzeck*, for Berg's even more powerful opera, the twentieth century *Wozzeck*. After the initial study of the literary raw material, I explore scene by scene to see how music takes over to tell the story. Consideration of mis-en-scène comes after that, as time allows.

Have I given my students weeks of cultural conditioning so they can better enter the world of *la grande bourgeoisie*? Pierre Bourdieu might be right about the cultural capital of art. If so, why should only rich people with privilege enjoy it? If cultural conditioning is necessary, let's give it to our young people and find a way to usher them into this *culturally* rich world, a world that offers lifelong pleasure, solace and the best of company.

The NEA report on reading contains disturbing confirmation of a situation that many of us already suspected. The group least likely to read literature is the 18-24 age group. The young and future readership for literature is not there, and I suspect they are also missing from the audience. These people know everything about music swapping and ipods and googling. They are not very likely to read *War and Peace* or

to hear a Beethoven *sonata*. The report also indicates that those most likely to read go to the art museum and the concert hall, confirming my suspicions. They are also absent from the classical music audience.

This is one more reason that I have a Crocean belief, possibly instilled by my old friend, teacher and colleague, Giancarlo Maiorino, that the arts are best taught together.

Reading is not separate from looking at and listening to art.

Leon Botstein's summer music festival (Bard Festival) at Bard College is in many respects an admirable model. For fifteen years or so, he has hosted a summer festival that concentrates on the work of a single composer, assembling scholars and performing artists to investigate unfamiliar and well-known repertoire together in an academic setting. Scholars, often speaking on interdisciplinary subjects, discuss and lecture. All of this takes place in two weekends in the summer. A scholarly book, published by Princeton University Press, is published in time for each festival, and those who attend often buy it. I was lucky enough to be asked to participate once, and the whole experience was very stimulating, provoking some of my continued thinking on the topic of how the humanities can help classical music.

In my view this type of thing should be emulated and done elsewhere in different ways. More should be done over a more sustained period, covering perhaps an entire academic year. Activity over an extended academic period is sorely needed to create a sustained impact and to find tomorrow's audiences, thoughtful engaged, dynamic and young audiences who will bring something new to something old, however worthwhile and worth saving. We need the young to save the old. From this young audience will emerge tomorrow's philanthropists.

In the case of Debussy, a festival was needed and pianist Jean-Louis Hageuenauer (an authoritative interpreter of Debussy) and I organized one, benefiting from the tremendous talent in the School of Music at Bloomington. Beethoven is more commonly performed in a great conservatory, but I have still required attendance at a minimum of five concerts this fall. There have been two performances of the Diabelli variations by Edmund Battersby, who played both on an historical instrument and a modern piano. We have had the first, third, fifth symphonies, the mass in C, excerpts form the Prometheus ballet and more. However, I have been very disturbed about the sparse audiences in the symphony concerts. There were many enthusiastic music students in the orchestra on stage, not many more in the audience. I noted a few friends of the musicians. Of course, older people, among them the usual retired professors, were the majority. This is in Bloomington, where music is usually free of charge. It is a cultural Camelot. It parallels what we know about the diminishing attendance around the country in professional venues, but it is a protected environment.

As of September 2004, four of our top orchestras were facing major contract problems. The Cleveland Orchestra has a 7.4 million dollar deficit. The Chicago Symphony, the New York Philharmonic, and the Philadelphia Orchestra have multi-million dollar deficits. These are the best of the best, all with huge endowments and mutual funds, and they will survive. They have huge endowments and mutual funds and someone will bail them out. But imagine what is going on at the middle and the bottom tiers. [The falling mutual funds and very high salaries for conductors are part of the problem, but so is falling attendance, and that is my concern]

A few more indications of the crisis. No serious classical musician is ever featured on the endless talk shows in the media. They are simply out of the mainstream now. The parent company of Tower Records, the biggest chain record/cd store, was recently in serious financial trouble, which is itself a cause for concern. For years before this recent trouble I've been saddened to see classical music hidden in the back of the superstore, or off to the side, through heavy doors. Tower Records has lost market share to Wal Mart and Best Buy, where it is almost impossible to find any serious music. *Billboard* the financial journal of the music business hardly bothers to list information about the classical music industry.

The conductor James Conlon, speaking at the Juilliard commencement last spring, told the young musicians graduating there that they should be ambassadors of culture. They will have to be. But we should do our best to create a future for them. And we should train students to be ambassadors for music, to speak well about it in addition to training to play perfectly in a competition. They will need diversified skills.

I close by making some general recommendations about what to do. The problem of classical music is a case that applies to the general situation in our culture. We need a better coordination of resources in undergraduate education. I recommend that teachers take a special look at whatever is local or at hand: museums, theater, architectural sites, obviously, in the case of music, musical venues. These should be related to classroom study. Study in the classroom should be enlivened by cultural practice. Cultural practice should be supported by humanities study, extensive reading in biography and cultural history, teaching simple tools of analysis, scholarly activity, exploratory research papers and projects, discussion, review and everything else that can be done in the humanities classroom to stimulate students. In general, classes should be coordinated with cultural events on a continuous basis, and on a much larger scale than I have been able to do so far. Sustained study has lasting meaning for students. A quick trip to the concert hall or museum or theatre is not enough. (once again, I operate on a small scale, a pleasure in itself, but I call for a larger range of operations)

I would like to see large humanities classes connected to many types of arts events: master classes, concerts, plays, also museum visits. A clear course of study should be the basis for coordinated resources. A variety of interrelated courses could be offered at the same time, justifying increased funding for a large cluster of students. This would give the best framework for special scholarly events--bringing outside speakers and performers, for example. Required attendance at these events could be linked to classroom study more efficiently. Performances and "*Informances*" should go together. Panel discussion, community discussion, classroom discussion is essential afterward. The institution could arrange for public panels featuring artists talking about what they do (many otherwise educated people today have no idea). Some master classes should be open to interested, prepared humanities classes, and perhaps to the public. Selected artists do this well (the legendary master classes of George Sebok and Janos Starker are examples). Find them, select them, court them.

A strong theme is needed. One is the organization of events around the study of a single figure, but there are obviously others. There are great opportunities for cultural tourism and development at each college campus. The possibilities are enormous.

The Lotus World Music Festival is an example of how an innovative non-profit organization, without any permanent university link, has stolen the thunder from the university at Bloomington. Our School of Music, great as it is, has done nothing like it. The Lotus Festival appeared out of nowhere and now has become a trademark event in our small midwestern city, attracting people from all over each fall, offering a combination of educational and cultural activity. But more could be done with a better humanities plan behind the festival.

Doors have to be opened in a welcoming manner. Snobbery and intimidation is of no use. We have to pass on the accomplishments of a civilization and make them available to the young. There is an emergency, but we have considerable resources at hand at the universities and colleges and community colleges around the country. Leadership is needed. The humanities should take a leadership position in opening up doors and in opening up those doors the humanities can find a new identity and purpose.

Breakout Session: Engineering and Computer Science: Do New Fundamentals Require New Pedagogies?

Leader: Karan Watson, Dean of Faculties and Associate Provost and Regents Professor of Electrical Engineering, Texas A&M University
Recorder: Shannon D. Henderson, Graduate Student, Interdisciplinary Engineering, Texas A&M University

Presentation

With the arrival of the information age and the knowledge explosion in science and technology, education that focuses on transmission of today's facts and mastery of current skills is increasingly shortsighted. Leaders of science and technology and informed citizens have to be cognitively flexible life-long learners in order to create and keep pace with future advances. We must therefore prepare students to apply knowledge and skills in new ways and to new contexts. This session set out to a create dialogue about what is fundamental for the educated engineering and computer scientist, given the rapid changes created by research and development in the fields.

As noted by cognitive psychologist Diane Halpern in testimony to Congress on the science of learning, "The sole reason we have schools and universities, that is formal settings for learning activities, is that we expect that learning will transfer. Information learned in one context can transfer to a different context, but we need to teach in ways that encourage transfer." If we are concerned about the transfer of learning, what changes regarding current pedagogies raise questions or concerns? What pedagogical changes are promoted as necessary now?

Many of the fundamental structures, educational systems and teaching methods that are in place at universities derive from the Enlightenment, when an "educated man" was marked by his breadth of knowledge and his reasoned thought processes. Although universities have changed enormously over the centuries with respect to student populations, topical coverage and emphasis, and pedagogical approaches, including the use of instructional technology, their underlying structure has remained fundamentally unchanged. Models of education based on simple knowledge acquisition and without regard for how that knowledge will be applied in diverse personal and societal contexts still prevail. These models, however, no longer work. What is needed is a re-examination of current structures and pedagogies. Until we decide what the fundamentals are that we seek to impart to students, we cannot determine what pedagogical changes are needed to best facilitate students' success, while simultaneously supporting the needs and goals of our society.

The National Academy of Engineering (NAE) and the Accreditation Board for Engineering and Technology (ABET) have each developed their own list of "fundamentals"—of the minimal requirements they perceive for a well-rounded, successful engineer. To the members of the NAE, engineering graduates in the year 2020 will:

- Possess strong analytical skills, like engineers of yesterday and today
- Exhibit practical ingenuity
- Be creative
- Be good communicators
- Master the principles of good business and management
- Understand the principles of leadership and be able to practice these principles
- Have high ethical standards and a strong sense of professionalism
- Possess a complex attribute described as dynamism, agility, resilience, and flexibility
- Be life long learners

ABET's fundamentals for engineering and computer science graduates include:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs
- An ability to function on multi-disciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

It should be noted that skills in design/creation and a capacity to stay "change ready" is in one form or another on both lists. The high premium placed on these requirements suggests that an additional fundamental requirement should be skill in conducting research. Well crafted, undergraduate research experiences offer one of the most efficient approaches through which students can develop and strengthen most of the skills the NAE and ABET identify and demonstrate their acquisition of them. Further, the student's achievement of these fundamentals can be readily assessed.

FUNDAMENTAL	ASSESSMENT

• Design/Creation
  • Setting for design
  • Reason/context/meaning of design
  • Process for design
  - What is already available
  - What are the constraints
  - What is known
  - What is needed
  - Assessment/Iteration
• Staying change ready
	• Good Research
	  • Knows the state of the current knowledge
	  - What's known
	  - What's unknown
	  • Can decide what we need to know next
	  • Can design experiment to find out
	  • Can share what is learned

Engineering faculty should craft their endeavors so that all undergraduates have experiences that foster their achieving the desired fundamentals. Given the tight interaction between research design and change readiness, meaningful involvement in research would seem essential. Not only does it give students a hands-on experience doing the work, but they also gain an appreciation of when to be able to use research discoveries and when research is needed, and they gain understanding of the difference between research and design. Equally important, a productive research experience fosters the development of several required fundamentals, including:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to identify, formulate, and solve engineering problems
- An ability to communicate effectively
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues

Such experiences should be made available to all students; they should not be limited to the subset of students that Engineering departments and schools are recruiting for graduate school.

Discussion

The discussion addressed the critical issue of what changes need to be made in undergraduate engineering education if we are concerned about students' developing and having the ability to transfer these fundamentals. Taking into account the diversity of the students they teach, how can Engineering programs help students to develop the breadth and depth of knowledge they will need to work in a range of environments. How can programs take advantage of the tools that are now available?

While incorporating research experiences into the curriculum represents one way of promoting the fundamentals the NAE and ABET mandate, a second approach is through changes in pedagogy. Pedagogies that foster the kind of problem solving, analytic and communication skills engineers require include: Team teaching and team projects, active learning within the classroom context, problem-based exercises, design integration and authenticity, the integrated use of modern tools and experiential learning.

Session participants together engaged in an exercise to map elements of the undergraduate research experiences to ABET outcomes. Participants were asked to:

- Describe the requirements of your research experience for this mapping.
- Describe assessments of your research experience.
- Place your experience in a curriculum.

The exercise demonstrated that there are different spectrums of research experiences that map to various outcomes associated with ABET or any other required skill set.

One issued that was raised in the discussion was "engineering identity." An identity development occurs within engineering that is not often addressed in undergraduate engineering education. Perhaps because of the perception of Engineering as a profession rather than an academic discipline, during their course of study engineering student becomes "engineers" as opposed to "students of engineering."

The drivers for a research experience within undergraduate engineering education should be engineering faculty and leaders within the profession. Without throwing out everything we know about engineering, engineering educators should develop a process that uses and builds upon what we do know.

Recommendations

- Engineering programs should immerse students early in the research process. Having an early experience will not only validate its importance, but it will present the student with a holistic view of engineering.
- Faculty should endeavor to incorporate research into their classroom teaching, not simply as an add-on, but as an integral component of the course that supports and reinforces course objectives.

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POWERPOINT PRESENTATION
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Breakout Session: Applying Principles of Learning in the Experimental and Data-Intensive Social Sciences, Related Areas within Psychology and Management

Leader: Milton D. Hakel, Ohio Board of Regents Eminent Scholar in Industrial and Organizational Psychology, Bowling Green State University
Recorder: Michael Gillespie, Doctoral Student, Department of Psychology, Bowling Green State University

Presentation

"Today, the world is in the midst of an extraordinary outpouring of scientific work on the mind and brain, on the processes of thinking and learning, on the neural processes that occur during thought and learning, and on the development of competence" (Bransford, Brown, and Cocking, *How People Learn: Brain, Mind, Experience, and School* [1999]). The question is how university instruction can benefit from this "outpouring" and draw on principles of learning to re-think both their curriculum and their pedagogy so that they become more learning-centered. Small changes in the way instructors carry out teaching-learning interactions can pay large dividends in student learning. We are present at the creation of a new "science of learning," with many ways in which we can better help our students create durable learning and integrated skills.

To begin with a concrete example, Porter & McKibben (1988) evaluated undergraduate and Master's level education in business, and found that graduates of business programs are often weak in the "soft" skills required for professional practice (e.g., leadership, working in teams, social interaction). They are also narrowly trained specialists, unable to integrate their technical knowledge from various courses to solve practical problems. The development of these required "soft" skills needs to be approached systematically across disciplines of study, just as the required knowledge also needs to be integrated across disciplines. What will be needed to improve educational practices, not only in business but in higher education in general?

First, it is crucial that we focus sharply on the student, rather than the teacher, the course or curriculum, or other facets of the learning situation. Here are two key questions: "Who is learning?" and "Who is learning for?" The obvious answer to both questions is "the student,"

but that answer is so easily ignored and forgotten. We must keep the student in the center of our thinking.

Second, learning is demonstrated in performance. Learning goes beyond knowing to being able to do what one knows. The key question is "What should a liberally educated person be able to do?," not "What should a liberally educated person know?"

When focusing on what students should be able to do, three core abilities come to the fore:

1. Critical and constructive thinking: analysis, synthesis, problem solving, judgment, and decision making.
2. All facets of communication: writing, presenting, reading, listening, information literacy, numeracy.
3. Social interaction: influencing others, participating in groups and teams, and leading in diverse settings and cultures.

These abilities are not domain-specific. Rather, they cut across disciplines. Yet, in current practice they are rarely assessed across domains. Instead, domain-specific knowledge is tested at the course level, and we are satisfied (or compelled by the lack of resources or vision) to stop there.

To illustrate the focus on student performance as the evidence of learning, imagine that every student gives a commencement address. This was required at Harvard College back in the 1600s. Giving a commencement address is a complex performance, one that demands integrative mastery of not only the content of one's major, but also the communication and social interaction skills so much in demand in today's global and interdependent community.

An outstanding example of what is possible in higher education comes from Alverno College. At Alverno the focus is on abilities (what students should be able to do) and on documenting the learning process through formative assessment. Alverno does so through a strong emphasis on publicly-defined learning outcomes and the use of electronic portfolio (e-portfolio) technology. With e-portfolios, students create, edit, and upload examples of their best performances for regular review, anytime, anywhere. Both baseline performance and the cumulative record of development are easily retrievable by students themselves, advisors, instructors, and other authorized staff members. This cumulative aspect gives students the capacity to go back and reflect, and to see changes themselves.

Key characteristics of Alverno college:

- It is a small and extraordinarily innovative private college located in Milwaukee, Wisconsin.
- Alverno faculty adapted assessment center technology from Wisconsin Bell and AT&T to assess and develop eight abilities for all of their students: Communication, analysis, problem-solving, valuing in decision-making, social interaction, effective citizenship, global perspective, and esthetic responsiveness.
- Assessment for learning is a part of Alverno's culture, and one can easily see the development of their students over time (e.g., in giving speeches). A video was presented depicting some students' progress at Alverno [the actual presentation did not play to completion due to technical difficulties with the LCD projector]. Documented progress, such as that "shown" during the presentation, is simply part of Alverno students' learning experience and developmental record, or portfolio.

In part to implement some of the practices that Alverno has pioneered, and to provide a way to assess new practices coming from applications of the science of learning, Bowling Green State University and other institutions have adopted e-portfolio technology as a way to track cumulative student development. At BGSU the features desired of e-Portfolios software are:

- Easy use
- Access anywhere, anytime via a web connection
- Inclusion of audio and video files
- Under joint control, and in the institution's possession
- Sophisticated security and access permissions
- Search by title or any indexed attribute
- Trace cumulative patterns of learning
- Compare portfolios of many students
- Scalable

Electronic portfolio technology provides many opportunities for fostering innovation in higher education, both by enabling students to document their own learning and by serving as an observation instrument for evaluating applications derived from science of learning principles.

In sum, universities need to become learning-centered institutions that will:

- Achieve clarity about learning outcomes in critical and constructive thinking, communication, and social interaction
- Coordinate teaching and assessment to promote student learning
- Align structures and resources to serve student learning
- Work continuously to improve the environment for learning

This leads to three recommendations for instructors, administrators, and policy-makers:

1. Instructors need to focus on how learning is demonstrated.
2. University administrators and individual faculty should explore how technology can aid students in learning and in documenting their progress.
3. Instructors should enlist undergraduates in providing the leverage for institutional change.

Discussion

The discussion had four main themes: (1) Professional development and resources, (2) culture, (3) the assessment and evaluation of teaching practices and student learning, and (4) ways to involve undergraduate students in research.

Professional Development and Resources

In order for faculty to incorporate undergraduates into their research, and truly focus on teaching them what they need to be able to do, resources need to be explicitly devoted to faculty professional development. Further, instructors need to be given a realistic presentation of the resources that would be required of them in order to meet these goals. The reason for the focus on professional development is that faculty themselves need to be instructed on how to teach and mentor effectively. Without this explicit attention, perhaps as emphasized by administrators, some faculty will be too busy to dedicate time to their own teaching development and will find ways of excusing less-than-ideal performance.

In determining where to focus professional development and additional resources, we need to adopt a long-term time frame, starting with graduate students as future teachers, in order to have a large impact. It will take time for the needed changes to occur, so we need to focus on the instructors of tomorrow. This was asserted as being particularly relevant for research universities.

To help achieve these goals, it will be useful to look into other organizations in addition to the Reinvention Center, that have had similar goals. Two that were mentioned were the National Conference on Educational Research and the Council on Undergraduate Research. Also, programs for preparing future faculty, like that implemented at the University of Waterloo, offer additional ideas for change.

Culture

Perhaps the most discussed underlying theme was changing the institutional culture to be more supportive of incorporating undergraduates into research, and to place emphasis on student learning. Some participants noted that the issue is not one of available resources, but rather one of climate (a close relative of "culture"). The consensus was that we need social, possibly formal, reinforcement from established faculty members; otherwise, faculty are not motivated to make new notes, or develop new syllabi because they can more usefully spend their time doing their research which is more heavily reinforced.

It was argued that the culture is a direct function of what gets rewarded. One issue here is the relative reinforcement for developing undergraduate students versus other competing objectives, such as research productivity. For example, it was asserted that in order to get tenure, a candidate's teaching need only to be acceptable or good. It is generally true that if one is an excellent scholar, tenure will be granted irrespective of teaching. By contrast, if one is a mediocre to poor researcher, yet one of the "best teachers" on campus, tenure is quite unlikely to be granted.

Moreover, even within the domain of teaching evaluation (identifying the "best teachers"), it is not learning per se that is assessed and reinforced. Rather, typical teaching evaluations are more related to likeability, attractiveness, and how easy the class was. We need to provide better resources for demonstrating effectiveness. For example, it is important for any psychology major to learn transferable skills without having to go to graduate school. We need better teaching assessment tools. One participant suggested that a federal mandate to demonstrate effectiveness may be a key. Along these lines, another participant made a proposal to his own institution to assess students' transfer of learning five years after their class instruction. As it turned out, this was not feasible, as faculty objected to the collection of outcome data of this type. The bottom line, it was concluded, is that student evaluations are all we really have right now. However, we could make them more scientifically valid and useful. Some suggestions for this are provided in the "Assessment and Evaluation" section.

Assessment and Evaluation

The best way to measure learning is by valid assessments of long-term retention and transfer of the desired skills, knowledge, and attitudes. Unfortunately, current practice generally measures only short-term affective student reactions. In support of this assertion, one participant referred to a study reported on PBS that found no significant difference between day one and last day teacher evaluations.

Participants suggested some ways to improve teaching evaluations: (1) Ask "how much time do you spend working on this class?" This has a positive relationship with "what you get out of the course." (2) Ask "How challenging was this class?" This is a question that "cuts in the opposite direction" from the popularity/likeability issue. (3) After they have completed a course have students write letters describing meaningful experiences in it. (4) Ask students more long-term, utility-oriented questions such as, "How likely is it that you will use what you've learned in this course after you graduate?"

The Virginia College System requires evaluations similar to what has been outlined here. The evaluation consists of a writing requirement and a senior exit survey. There is an assessment committee within departments that evaluates the senior exit requirements as part of a University outcomes assessment. The department committee makes the initial assessment and gives it to the University's Assessment Office, which reviews and provides feedback to the department, and provides a summary to the University. This University report is then provided to the State.

Involving Students in Research

There were four basic recommendations: (1) Engage students in research within classes, not just as one-on-one protégées. (2) Consider what the purposes are of involving undergraduate students in research, and bring these purposes into the classroom. (3) Be creative: One example of a way to engage the students is to have them bring in an advertisement and think critically about it (e.g., the 4/5 dentists recommend… commercials). (4) Make the learning experience something that they can use by providing updated and relevant lecture materials. One problem with this approach is that time spent updating course content is time away from writing. Some professors even feel guilty about spending time updating their lectures. (This goes back to the culture and evaluation topics.) A possible solution is to have the students bring in the relevant materials, and update the lectures, in some ways "killing two birds with one stone."

Recommendations

For Individual Campuses

- The goal of instruction needs to be to foster student learning that is durable and transferable to relevant domains of practice. Campuses need to develop tools that demonstrate the extent or degree of student learning.
- Faculty and professional staff need to investigate how technology can aid students in learning and in documenting their learning.
- Instructors need to get students involved in their own learning experience, and enlist their help to effect institutional change.

For The Reinvention Center

- The Reinvention Center should highlight complementary programs, such as the Council on Undergraduate Research and the National Conference on Educational Research, that have been successful in pursuits similar to those of the Reinvention Center.
- The Reinvention Center should adopt a long-term perspective in an effort to cultivate a climate that is receptive to undergraduate research, focusing on (a) current graduate students, who will be professors in the future, and (b) tenured/senior professors who can provide leadership among their peers.
- The Reinvention Center should create professional development resources that can be provided to member universities. One focus of these resources should be on provoking student engagement, for example, asking the "why" question (see Bjork's talk at this conference) and providing timely examples that are relevant to the students.

Resources/References

Websites

1. The Council on Undergraduate Research (CUR): http://www.cur.org

2. Alverno College faculty have been developing and implementing ability-based undergraduate education, redefining education in terms of abilities needed for effectiveness in the worlds of work, family, and civic community. http://www.alverno.edu
3. The BGeXperience at Bowling Green State University is an academic program designed to help all first year students make a successful transition to college: http://www.bgsu.edu/students/bgexperience
4. E-portfolio Project is part of Bowling Green State University's Rhetoric program's initiative for assessment of the program and assistance in job placement for its students. http://www.bgsu.edy/departments/english/Portfolio/portfolio.html
5. Learn how to create your own electronic portfolio at http://electronicportfolios.com/portfolios/howto/index.html
6. Georgia State University offers a forum for sharing comments, ideas, news, links and information about e-portfolios http://anvil.gsu.edu/eportfolio/
7. The University of British Colombia's electronic portfolio Website includes "how-to" information and current e-portfolio projects, events, and resources. http://www.elearning.ubc.ca/home/index.cfm
8. Regis University's Portfolio Project Website lists several e-Portfolio commercial software options and examples of universities using the programs as well as descriptions and prices of the software. http://academic.regis.edu/LAAP/eportfolio/software.htm
9. The 2002 Report of the VCCS Task Force on Assessing Core Competencies can be found at http://www.vccs.edu/competencies/taskforcereport.pdf
10. UC Berkeley's Leadership Development Program's (LDP) e-Portfolio report is available at http://bearlink.berkeley.edu/ePortfolio/index.html

Publications

1. Bransford, J.D., Brown, A.L., and Cocking, P.R., Eds. (1999). *How People Learn: Brain, Mind, Experience, and School.* Washington, D.C.: National Academy Press.
2. Porter, L.W. and L.E. McKibben (1988). *Management Education and Development: Drift or Thrust into the 21st Century?* New York: McGraw-Hill.

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Hakel/Powerpoint.pdf

Breakout Session: Applying Principles of Learning in the Humanities and Discursive Social Sciences

Leaders: Lucia Albino Gilbert, Vice Provost and Frank C. Erwin, Jr. Centennial Honor, Professor of Educational Psychology; Cory Reed, Associate Professor of Spanish Literature; Paige Schilt, Director of Bridging Disciplines Program; Sean Theriault, Assistant Professor of Government; and Paul Woodruff, Darrel K. Royal Professor in Ethics and Director of the Plan II Honors, University of Texas at Austin
Recorders: Lucia Albino Gilbert, Paige Schilt, and Cory Reed

Presentation

The session focused on what university administrators and faculty can do separately and jointly to make participation in research an integral part of learning for undergraduates in the humanities and discursive social sciences. The leaders presented four initiatives undertaken at the University of Texas at Austin. Two are university-wide activities initiated at the provostial level. Another, created within a college at the University, involves both curricular and co-curricular activities. The fourth initiative is an innovative undergraduate class developed by a faculty member. Collectively, these initiatives are designed to excite students about research in the humanities and discursive social sciences, prepare them to participate in a meaningful way, and then facilitate their participation.

The session began with a presentation of a new provostial-led initiative, EUREKA, followed by a description of a long-standing university-wide honors program known as Plan II. These two models are examples of the critical role senior administrators can play in creating structures and resources to facilitate undergraduate participation in research. While the UT initiatives benefit students in all disciplines, they can be particularly helpful in the humanities and lettered social sciences which lack a tradition and models for undergraduate scholarly activity apart from honors theses.

EUREKA: Enhancing Undergraduate Research Experience Access Knowledge. EUREKA (www.utexas.edu/research/eureka) is a searchable database designed to facilitate undergraduate participation in research in all fields. Launched in 2003 by the Provost's Office, it represents a collaborative university-wide effort. Session leaders Gilbert and Schilt gave the presentation on EUREKA.

Background

In response to the Boyer Commission report, in the fall 2000, the Provost's Office established Connexus: Connections in Undergraduate Studies, a cross-college unit charged with enhancing undergraduate education at UT Austin. EUREKA was an outgrowth of this effort as Vice Provost, Lucia Gilbert, who had oversight of Connexus, quickly recognized that students needed some way to learn about faculty members' research program so that they could connect with faculty whose work overlapped with their broad interests.

EUREKA's development was guided by two principles. One was that increasing undergraduate participation in research was a University priority and the University needed to be ready to respond to and support student demand as this priority became a reality. The second was that EUREKA's primary role would be to support and complement the range of structures already in place that had undergraduate research as a goal. These included units like Connexus, research centers on campus, and academic departments, as well as support units such as the archives and technology offices.

Although the Provost's office led the effort in creating EUREKA, steps were taken throughout the planning stages to gain buy-in and active collaboration from the various schools, colleges, and interdisciplinary units on campus and from the Vice President for Research. Units within the Provost's office provided technical expertise and data entry. The driving interest for all was to design a resource that could assist students, faculty, and even the University's Office of Public Affairs.

The vision and energy that accompanied its development has been key to sustaining EUREKA. It the year since its launching, EUREKA has become a central resource on campus for information on faculty research. Equally important, it has been proving to be successful because it is integral to the University's larger mission to expand research opportunities for undergraduates and because of its demonstrated usefulness to students, faculty, and the administration.

The Model

EUREKA has three key elements:

- Two full-time professional staff who serve as Research

Coordinators. One works across colleges, while the other is specific to the College of Natural Sciences.

- A close link with new Connexus cross-disciplinary programs that are built around undergraduate research in all fields.
- Sufficient funding to provide research scholarships and awards for participating students and faculty.

Is EUREKA facilitating increased research in the humanities? Are cross-disciplinary programs that are more humanities-based attracting student participation in humanities research?

In the first year EUREKA was implemented, 10% of all inquiries to the research coordinators came from humanities students; 46% of the students in new cross-disciplinary programs are from the humanities. The EUREKA model serves the humanities in several ways:

- The combination of EUREKA and the research coordinators creates a mechanism for faculty to mentor students in research.
- It calls attention to and makes visible faculty in the humanities who are active researchers.
- It publicizes the nature and variety of scholarly activities going on in the humanities.
- It helps engage students in the excitement of humanities research.

Session co-leader Schilt demonstrated key features of EUREKA (www.utexas.edu/research/eureka):

- As a complement to the searchable database, EUREKA offers a research guide with tips on developing the necessary skills for a research experience, approaching faculty members, finding scholarships, and publishing.
- EUREKA offers different search options for users with different needs and levels of sophistication. Users may search the database by keyword, subject heading, department, or research unit.
- The list of general, interdisciplinary subject headings allows entry-level users to get a sense of the breadth and diversity of research on the UT at Austin campus. This list is especially valuable for the humanities because categories such as "nation and national identity" or "ethics" can help students develop a sense of the ways in which research is conceptualized and discussed across disciplines.
- Individual faculty records allow students to appreciate faculty members as researchers.
- Students who express an interest in a particular faculty member are connected with a Research Coordinator who facilitates contacts between faculty and students, and protects faculty time by helping students become better prepared and informed.
- Faculty members who are looking for a research assistant may list a specific project on EUREKA. Similarly, students have the option of entering a research profile, which is then available to the faculty.

Plan II, a long-standing university-wide honors program, is another example of a cross-college program developed with support from the Provost's office. The goal was to prepare academically-talented students for a meaningful research experience in the senior year (www.utexas.edu/cola/plan2/). Session leader Woodruff gave the presentation.

The Plan II curriculum has been developed over the course of many years by the Plan II Honors Program, which admits about 180 students each year and graduates 150 to 160. All students write a senior thesis in the senior year. The key elements are described here:

Year One:

- A year-long literature course, taught in seminar style, with emphasis on writing and on graded oral presentations, some of them related to research.
- A one-semester "tutorial course," taught in seminar style, with emphasis on writing and on graded oral presentations, some of them related to research.

Year Two:

- Continued work on writing and speaking in courses in philosophy and the social sciences.

Year Three:

- Two seminars, taught by experts in their fields, on topics involving research and covering research methods in the field of the course. Every student is guided through the process of writing a research paper.
- A course under development on the oral presentation of research.

Year Four:

- A two-semester senior thesis project, consisting of one semester (and sometimes also a summer) of guided research and reading, followed by a semester of writing. Students are not permitted to embark on projects for which they have not been prepared by coursework in the second and third years.
- A thesis symposium at which all graduating seniors present their work orally in a conference-type session in early spring. The symposium helps focus the students on the main points about which they are writing, and it also allows them to share their results.

The Plan II program is open to students in all majors and therefore has had to be flexible. Scientists and engineers, for example, may be working on teams led by a professor and writing up their part of the results, whereas humanities students may do independent research. Creative projects are allowed, but only for students with substantial backgrounds in the art in question, and only if accompanied by a treatise. Students who are doing scientific and technical research must write their introduction, abstract, and conclusion so that they can be understood by lay readers. This requirement has been instituted because scientists must be able to explain the value of their work, just as, later on, they will have to do in order to obtain grants.

Moving away from provostial-led new university-wide initiative and the university-wide honors program, the third presentation was on the Tracking Cultures Program, a non-honors model created within a college at the University. This program focuses on critical thinking and research engagement by providing interdisciplinary study within the humanities linked with a series of specific study abroad experiences (www.utexas.edu/cola/stdy_abroad/ goto/study_abroad/tracking _cultures/). Session leader Reed spoke about this model.

The Tracking Cultures Program (TC) is a faculty-led interdisciplinary program with a study abroad component that investigates the historical roots of southwestern culture in Mexico, Spain, and North Africa. Students take four courses on campus in the spring semester and then travel through the Southwest during spring break for on-site fieldwork. Fieldwork continues in the summer in Mexico, Spain, and Morocco. The program's final academic project is an in-depth report on a topic relevant to the student's individual program of studies. A series of guided writing exercises throughout the spring semester introduces the student to the basics of research and encourages the development of analytic and critical thinking skills. Faculty from several departments cooperate in teaching the core academic courses of the program, which offer a balance of chronological periods and disciplines. Topics in program courses and student reports focus on issues of ethnicity, politics, material culture, literature, art history, architecture, cultural identity, religion, technology, medicine, colonialism, sociology, and other related subjects.

The ultimate goal of the program is to promote a more sophisticated cultural awareness and understanding. It has several elements that are pertinent to the issue of encouraging and incorporating undergraduate research in the classroom.

- The interest factor of foreign study and travel in attracting students to discovery and research
- The interplay of independent exploration and collaborative peer groups in creating enthusiasm and "ownership" in research
- The use of guided assignments to help students identify, choose, and write on a specific topic
- The use of interdisciplinary studies to introduce students to models and approaches to research in multiple disciplines
- The role of graduate students as peer mentors in promoting undergraduate research

The next model, presented by session leader Theriault, is an example of a faculty-driven effort. To provide some context, the Government Department at UT Austin is the largest department in the largest college, with more than 40 faculty and over 2000 undergraduate majors. Theriault teaches a large, non-honors undergraduate class. What makes it special is that the students actively work on aspects of an instructor's research and through this engagement develop a scholar's mode of thinking. The students begin their work on the project in the fall semester within the large-class context; they continue on it the following semester in a small group setting. The course URL is: www.la.utexas.edu/~seant/

Session leader Theriault emphasized the important role faculty play in creating this kind of course since this course did not originate with a vice provost, provost, dean or program director, but with an untenured assistant professor who was struggling to make research real to a classroom of unengaged and disinterested undergraduates.
In creating it, he had to address several challenges:

- Creating a mechanism for transitioning the research from the classroom to the "laboratory," as it were; replacing the traditional mentor-guiding independent researcher model with one of a principal investigator coordinating researchers.
- Establishing the Undergraduate Research Group, which requires creating an infrastructure. The undergraduate research group in this instance is made up of five students per semester. The students receive credit equivalent to a regular classroom-based class. They may participate in the group only once in their undergraduate careers. Participants often apply for an Undergraduate Research Fellowship to go to DC to continue doing research.
- Creating reasonable requirements for both the instructor and the students. This course has three requirements: 1) The students must do a nominal amount of grunt work; 2) Although they work independently, their projects must be coordinated; and 3) They must prepare an eight-page paper that demonstrates their command of their subject and their scholarly capability.

The project around which the course is organized varies from semester to semester. Next semester, for example, the theme will be Civil Rights. Dr. Theriault anticipates having all five researchers exploring different policy making areas, testing to see if issues surrounding Civil Rights are the exception or representative of a larger trend for parties to unify around centrist options. The students' duties will be to pick four or five major bills involving the policy area over the last 50 years, read the Congressional Record, read the inside baseball analyses (from CQ), read secondary accounts (Washington Post), and analyze and characterize the debates. This model works well because students and faculty alike benefit.

Discussion

The discussion focused on the different roles the university administration, departments and faculty can play in promoting and facilitating undergraduate scholarship in the humanities and discursive social sciences. The university President, Provost and Deans can provide important leadership by emphasizing the centrality of research and scholarship to the university's undergraduate mission and their commitment to providing the opportunity to do research to all students, regardless of major. These leaders can also provide funding for curricular innovation and for the establishment of programs like Plan II and the "Tracking Cultures Program" which have research at their core. Offices like that of the Vice Provost for Undergraduate Education can create structures and resources like EUREKA that promote and facilitate research and scholarly activity. The articulation of the undergraduate research mission message, coupled with actions that demonstrate the university's commitment, can be particularly helpful in humanistic and social science disciplines that lack a tradition of undergraduate scholarship. At the same time, faculty initiative is equally critical, as Dr. Theriault's government course demonstrates.

There was considerable interests in EUREKA as session participants sought information on such practical matters as how it was developed, how it is being maintained and how the data were entered. Several participants asked whether the UT at Austin could make the source code for EUREKA publicly available. Vice Provost Gilbert has indicated that efforts to do this are currently underway.

Much of the discussion focused on the question of how to get faculty in the humanities to consider taking on an undergraduate. More mechanisms are needed for sharing support stories. One suggestion was to offer an annual prize for the "best undergrad/faculty collaboration." Another approach is to create summer fellowships for faculty to work with students. It is crucial to match student interest with faculty interest.

There was agreement that rewarding faculty is essential. We have to create incentives for faculty not only to supervise the conduct of scholarly activity, but to help cultivate and prepare students so that they get to the culminating stage. Since not all faculty in the humanities require research grants to do their work, other means for rewarding collaborations with undergraduates must be developed. Some universities and some departments "count" supervision of undergraduate work toward tenure, promotion, and other rewards. The Reinvention Center can use its position to urge research universities to implement some kind of reward system. There was concern that the importance of undergraduate research has not yet fully penetrated to the departmental and dean levels. If this is the case, what can we do to protect junior faculty who become involved in undergraduate research?

Participants stressed the importance of recognizing that there are stages in preparing students for undergraduate research. How do we reward the work that faculty members do to cultivate student researchers? On the other hand, we also need to recognize that undergraduates are capable of presenting and publishing their work.

What constitutes "undergraduate research" in the humanities remains unclear. One session participant proposed that the Reinvention Center develop an inventory of the kinds of undergraduate research projects in the humanities that are already flourishing at research universities. Humanities faculty and departments need more examples. The Reinvention Center is taking up this recommendation and working on developing the inventory. Campuses that have projects that should be included should contact the Reinvention Center (reinvention@sunysb.edu).

There was some discussion of the value of library work. Some argued that such work is basically an introduction to the basic skills of data gathering in the humanities. Stephen Greenblatt was mentioned as an example of a prominent scholar in the humanities who uses students to do preliminary research.

Another question that was raised was, "What is being reinvented here?" We need to have a more in-depth discussion about critical pedagogy and reinventing research institutions. We also need to expand our discussion to factors outside the universities that influence what humanists do.

Finally, it was suggested that humanities departments need to find more ways to involve graduate students. One suggestion was to create teaching or graduate assistantships that involve a component of mentoring undergraduate researchers?

Recommendations

For Individual Campuses

- Offices that have campus-wide responsibility for undergraduate education should provide leadership and work with departments to structure four-year curricula around the goal of preparing undergraduate students to do research as a senior project.
- University should revise their guidelines to include the supervision of undergraduate scholarly activity and other activities that promote inquiry and scholarship by undergraduates among the criteria that are used to determine tenure, raises, and other rewards.
- Departments should take advantage of the presence of graduate students and post doctorals in organizing a mentoring chain from faculty to undergraduates.
- Offices should work with humanities departments to organize and provide support for campus-wide events that showcase student accomplishments in the humanities.
- Offices that have campus-wide responsibility for undergraduate education should establish mechanisms like UT Austin's EUREKA source code to assist humanities departments.

For The Reinvention Center

- The Reinvention Center should provide leadership in bringing together leading humanistic scholars who, speaking in one voice, try to persuade granting agencies to give greater priority to collaborative research projects that involve undergraduate students and to provide funding for projects that involve undergraduates.
- Again, speaking in one voice, this cadre of scholars should develop coordinated, centralized strategies for changing the "culture" of large research universities regarding undergraduate participation in research. Specific activities might be to make UT's Austin's EUREKA source code public; organize undergraduate conferences across campuses.
- The Reinvention Center should share success stories about undergraduate research in the humanities on the Spotlight pages of the Center's Web site and at regional network meetings.
- The Reinvention Center should conduct a survey of models that have been implemented on different campuses to promote and facilitate undergraduate pursuit of scholarship in the humanities.
- The Reinvention should sponsor forums, perhaps through the regional networks, that showcase students' work in the humanities. It should offer prizes in recognition of the students' accomplishments.

Resources/References

Websites

1. The University of Texas at Austin's searchable web resource, EUREKA: Enhancing Undergraduate Research Experience Access Knowledge, is a collection of research information and resources for undergraduates. www.utexas.edu/research/eureka/index.php
2. The Plan II program is a university-wide honors model at The University of Texas at Austin that prepares students for research in their senior year. www.utexas.edu/cola/plan2/
3. The Tracking Cultures Program at The University of Texas at Austin provides interdisciplinary study abroad opportunities within the humanities. www.utexas.edu/cola/study_abroad/goto/study_abroad/tracking_cultures/
4. In Sean Theriault's non-honors undergraduate class students are involved in the instructor's research and work on developing a scholar's mode of thinking. www.la.utexas.edu/~seant/
5. Connections in Undergraduate Studies (Connexus) is a cross-college unit that offers a diverse set of academic programs and resources that traverse boundaries between colleges and disciplines and enhances the quality of undergraduate education. http://www.utexas.edu/student/connexus/
6. The Freshman Seminars Program at The University of Texas at Austin offers small class-size courses that focus on the transition from high school to college-level writing and thinking; the identification of interesting subjects for research and future careers; and familiarization with university resources. http://www.utexas.edu/student/connexus/freshsem/index.html

Breakout Session: Applying Principles of Learning: From Assessment to Research

Leader: Diane Ebert-May, Professor, Plant Biology, Michigan State University
Recorder: Everett Weber, Research Associate, Plant Biology, Michigan State University

Overview of Session

The workshop was designed and implemented as a learning cycle model of instruction: Engage, explore, explain, and assess. This instructional framework is especially effective in promoting scientific teaching in large or small courses and in inquiry-based laboratories. Scientific teaching involves active learning strategies that engage students in the process of science and teaching strategies that have been systematically tested and shown to improve learning by all students (Handelsman et al, 2004). Students are engaged with a question, problem or example intended to probe their prior knowledge, they actively explore the content/concepts that are fundamental to the problem, and then explain their understanding of the problem based their findings. Assessments provide both students and instructor data that show how well the students achieved the learning goals and objectives associated with the problem.

Engage

At the start of the session, participants formed cooperative groups and placed their names in large letters on file folders. They also wrote personal information, such as their birthplace, classes taught, research interests, and an adjective their best friend would use to describe them, in smaller letters on the corners of the folders. Within each group, members passed their folders around so that all group members could get to know one another and form cooperative groups.

After the participants introduced themselves and formed groups, Ebert-May explained that within a class setting the folders served multiple purposes. First, the folders are a visual cue to help the instructors learn students' names. Depending on the seating design of the classroom, the folders can hang over the front of the desks or tables and be visible to the instructor, or students can hold them up for the instructor and one another to see. Ebert-May insists that she and her students call one another by name, and she also learns everyone's name. Students can turn in work completed during class in the folders. The formation of permanent cooperative groups, even in her large classes (300 plus students), creates a student-centered environment that promotes more student-student interactions as well as teacher-student interactions than the traditional classroom environment. Research on cooperative learning shows that all students in a course gain from these interactions if groups function with individual accountability and group responsibility as their guiding principle (Johnson, Johnson, and Smith 1998).

Another requirement is that students purchase a carbonless paper notebook pad (8.5" x 11", traditionally used in chemistry labs; easily stocked by bookstores upon request) so that they can maintain a record of their work in class (this is in addition to the web-based notes available for each class meeting). Scientists keep meticulous field and/or lab notes, another component of scientific teaching. Students use the carbonless paper to write quizzes, record conclusions from group problems, analyze data, and keep a copy of their daily work. The copy handed-in to Ebert-May may or may not be graded, depending on the goal of the work, and is not returned to students due to logistics and time associated with large numbers of students. Therefore, Ebert-May posts on the course Web site examples of 'exemplary' and 'needs improvement' responses to questions or problems that all students can use as a comparison to their work. Criteria for all class work is provided to students with a rubric (posted on the course Web page) that they are encouraged to use for both class work and home work.

Explore and Explain

Next, the principles of learning were explored in the context of assessment. Our intent was to move into research, but time did not permit. The exploration activity was designed using visuals, both slides (posted on the web site) and 'consensograms' (responses to questions for which the data are literally collected on large post-its). In this section Dr. Ebert-May is identified as Diane, with her name in bold font. Other participants, where possible, are identified by their first name. The slides are identified by topic and in bold letters. Results from the consensogram are presented in plain text after slide name.

Context of our Exploration

Faculty Institutes for Reforming Science Teaching (FIRST) is a national dissemination network funded by the National Science Foundation. The project is based at eight field stations throughout the U.S. and prepares faculty from colleges and universities from the geographical region of the field station to design and implement active inquiry-based learning using tested instructional designs (i.e., scientific teaching) in their undergraduate science courses so that all students can improve learning. Hence the FIRST II network supports faculty beyond the immediate project (such as the Reinvention Center faculty) to continue the improvement of undergraduate science education.

Objectives of the Exploration

As a result of participation in this session, participants will be able to:

- Assess learning in an inquiry-based student-centered classroom
- Examine objectives and alignment with assessments
- Analyze data to improve instruction
- Use data to move from assessment to research
- Choose research designs
- Figure out if rewards are worth it

Structure of the Exploration

Participants used small post-it notes to answer the following questions that appeared on slides. Participants then placed the post-its on a poster size post-it for each question and created a histogram of responses. The discussion generated by each question is summarized below.

Q1: Students learn best by doing science.
(Scale 1-5: 1 = strongly agree, 5= strongly disagree)

Q2: Science should be taught as it is practiced.
(Scale 1-5: 1 = strongly agree, 5= strongly disagree)

Diane: There are lots of ways to do science.

Audience: But there is a continuum from Q2

Diane: We need data to support how scientific concepts are best learned.

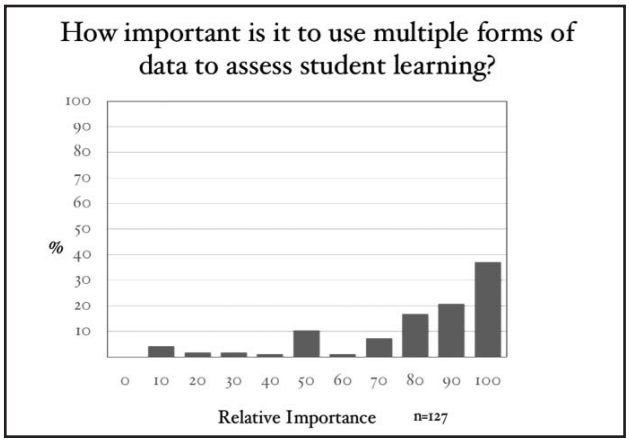
Audience: Problem-based learning became religion in medical school, but is now in decline. The problem was that although it might have been used to teach Pathology, for example, at the end

David: A lot of pre-professionals need to take exams.

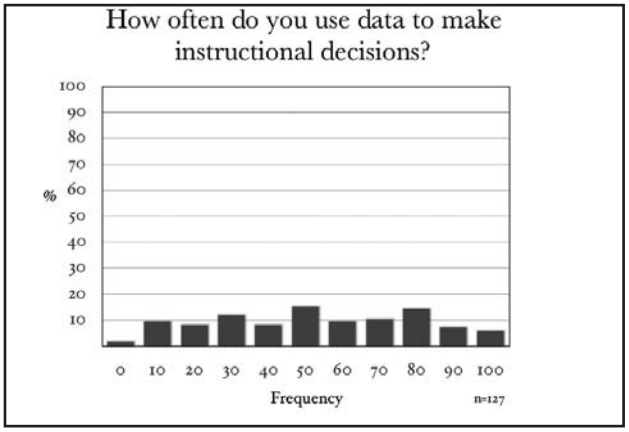
Diane: In two studies we conducted with both majors and non-majors in biology, students who took introductory biology courses that emphasized inquiry-based, active learning did not perform differently on standardized tests (e.g. MCATS and NABT biology exam) from students who took more traditional courses. Importantly, these active learning courses "covered" 25% less material.

David: Students who took classes characterized by how can we change the AMA requirements for medical school?

Q3: How important is it to use multiple kinds of assessment to assess student learning? (Scale: 0-100 in increments of 10)
The group response was not different from responses given by faculty in other workshops. Most faculty realize that multiple forms of assessment are important because the data provide insight into different ways students think about concepts and understand ideas. Assessments have multiple purposes, depending on the objectives of instruction, that range from recall of information to application, analysis and synthesis of concepts.



Q4: How often do you use data to make instructional decisions? (Scale: 0-100 in increments of 10) The group response, again, is similar to other groups of faculty nationally. There is a broad range of responses.



Dave: Does it include responding to missed quiz questions etc.?
Diane: Yes

Faculty are evaluated exclusively through the use of student evaluation forms at many institutions. Faculty must sort out what information student evaluations are actually providing, then evaluate if these data actually address the criteria for good teaching. In science, if the data collected are not appropriate to address the hypothesis, the results are meaningless.

Q5: Large lectures are active learning environments. (Scale 1-5: 1 = strongly agree, 5= strongly disagree) The highest frequency in responses was 3-4.

Q6: What percent of your time do you spend conducting research about student learning of your discipline? (Scale: 0-100 in increments of 10)

David: Are those people doing that as their research? I am a biochemist.

Diane: The people who learn most about what students learn are those in the disciplines.

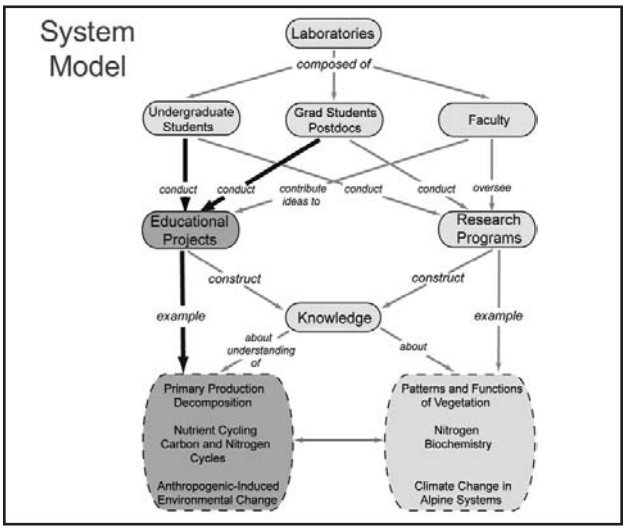
Patty: I enjoy doing research, but I don't like to do it on myself.

Diane: The culture of science is increasingly expanding to include scholarship in both science research and scientific teaching research, with some people conducting research in both. The tradition is not to do research on scientific teaching, but our group has burning interest to understand why students have flawed understandings of science.

Dave: Can we get funding for this kind of research?

Diane/David: Yes, lots.

This model describes the interconnections among faculty, students, scientific research and research on teaching. Scientists in the various fields of research are positioned best to probe and determine what students do not understand about their field. In preparing for an introductory plant biology class for plant biology majors, I went from lab to lab and asked, "What do you want students to know and understand to be a first-year graduate student?" I shall use these big ideas to scale back to the biological foundations that build toward the interesting questions driving cutting-edge research so students can have a relevant context for understanding the principles and concepts at the introductory level that they will develop and build upon throughout their program in plant biology.



Peter: What do the light lines represent?

Diane: The dark lines represent the new research opportunities. The light lines represent traditional research and lines of communication.

Q7: In my department, excellence in teaching is rewarded at a level comparable to excellence in research. (Scale 1-5: 1 = strongly agree, 5= strongly disagree) Respondents felt that teaching was not rewarded. The promotion and tenure committee are "us." So we determine the criteria for recognizing and rewarding various forms of research.

Question: How do we get our work about learning into the educational literature?

The questions that we ask about learning our discipline are part of the professional responsibility within our professional societies. Two examples of society publications that include papers on research in teaching and learning are the Pathways to Scientific Teaching series in *Frontiers in Ecology and the Environment* (Ecological Society of America), and Cell Biology Education (Cell Biology Association). Monthly, the Pathways articles provide an example of scientific teaching based on a research paper in that issue of the journal. The Pathways articles emphasize tested instructional designs, assessment, and research about learning.

Audience: At what level do you aim the articles?

Diane: I aim the articles at large classes because the literature is especially limited for those venues.

Chris: Psychology has a journal.

John: I have a concern. I am disappointed in the readership of journals. My impression is that the published articles aren't read.

Diane: Every member of the Ecological Society of America gets the journal, *Frontiers in Ecology and the Environment*

John: Cell Biology publishes articles on teaching, but pigeonholes papers to the side.

Adam: Try to send them off to *Science* and to PNAS (Proceedings of the National Academies of Science).

Diane: Until we get substantive, rigorous papers on teaching and learning, we will not get them published. There are many "how to" papers, but what we need are papers that have strong theoretical foundations in how people learn and address "why" questions re: students are not learning.

POLICY FORUM

EDUCATION

Scientific Teaching

Jo Handelsman,[1]* Diane Ebert-May,[2] Robert Beichner,[3] Peter Bruns,[4] Amy Chang,[5] Robert DeHaan,[6,†] Jim Gentile,[7] Sarah Lauffer,[1] James Stewart,[8] Shirley M. Tilghman,[9] William B. Wood[10]

Since publication of the AAAS report "Science for all Americans" (*1*), commissions, panels, and working groups have agreed that reform in science education should be founded on "scientific teaching," in which teaching is approached with the same rigor as science at its best (*2*). Scientific teaching involves active learning strategies to engage students in the process of science and teaching methods that have been systematically tested and shown to reach diverse students (*3*).

Given the widespread agreement, it may seem surprising that change has not progressed rapidly nor been driven by the research universities as a collective force. Instead, reform has been initiated by a few pioneers, while many other scientists have actively resisted changing their teaching. So why do outstanding scientists who demand rigorous proof for scientific assertions in their research continue to use and, indeed, defend on the basis of the intuition alone, teaching methods that are not the most effective? Many scientists are still unaware of the data and analyses that demonstrate the effectiveness of active learning techniques. Others may distrust the data because they see scientists who have flourished in the current educational system. Still others feel intimidated by the challenge of learning new teaching methods or may fear that identification as teachers will reduce their credibility as researchers (*3*).

This policy forum is needed because most scientists don't read reports but they do read *Science*. In addition, reports generally do not offer a guide to learning how to do scientific teaching, as we do with supporting online material (SOM) (*3*) and table (see page 522). We also present recommendations for moving the revolution forward.

Implementing Change in Lectures

Active participation in lectures and discovery-based laboratories helps students develop the habits of mind that drive science. However, most introductory courses at rely on "transmission-of-information" lectures and "cookbook" laboratory exercises—techniques that are not highly effective in fostering conceptual understanding or scientific reasoning. There is mounting evidence that supplementing or replacing lectures with active learning strategies and engaging students in discovery and scientific process improves learning and knowledge retention (*3*).

Introductory classes often have high enrollments, frequently approaching 1000 students in biology courses. This need not be an impediment to scientific teaching. Many exercises that depart from traditional methods are now readily accessible on the Web, which makes it unnecessary for teachers to develop and test their own (*3*). Quantitative assessment indicates that these interactive approaches to lecturing significantly enhance learning, and although time allocated to inquiry-based activities reduces coverage of specific content, it does not reduce knowledge acquisition as measured by standardized exams (*4*).

Faculty are also using computer systems to engage students, assess learning, and shape teaching. Students can be asked to read and solve problems on a Web site, and their answers can be analyzed before class to guide the design of lectures (*3*).

Some scientists have replaced lectures almost entirely. Laws' course "Calculus-Based Physics Without Lectures" at Dickinson University (*5*) and Beichner's program, SCALE-UP, at North Carolina State University (see figure, this page) rely on a problem-based format in which students work collaboratively to make observations and to analyze experimental results. Students who learned physics in the SCALE-UP format at a wide range of institutions demonstrated better problem-solving ability, conceptual understanding, and success in subsequent courses compared with students who had learned in traditional, passive formats (*3*).

These results are neither isolated nor discipline-specific. At the University of Oregon, Udovic showed dramatic differences between students taught biology in a traditional lecture and those taught "Workshop Biology," a series of active, inquiry-based learning modules (*6*). Similarly impressive results were achieved by Wright in a comparison of active and passive learning strategies in chemistry (*7*). Others have taught cross-disciplinary problem-based courses that integrate across scientific disciplines, such as Trempy's, "The World According to Microbes," at Oregon State University, which integrates science, math, and engineering. The course serves science majors and nonmajors, and outcome assessments indicate high content retention and student satisfaction (*8*).

A physics classroom at North Carolina State University arranged for traditional lectures (inset) and redesigned for group problem-solving in the SCALE-UP program.

Students as Scientists

Scientists of all disciplines have developed inquiry-based labs that require students to develop hypotheses, to design and conduct experiments, collect and interpret data, and write about their results (*9*). Many of these involve simple, inexpensive materials configured so that they invite students to ask their own questions. In addition to labs that have already been tested in the classroom, resources are available to help teachers convert cookbook labs into open-ended, inquiry-based labs (*3*). Some schools provide introductory-level students with the opportunity to conduct original research in a professor's research lab rather than take a traditional classroom lab course (*3*). These opportu-

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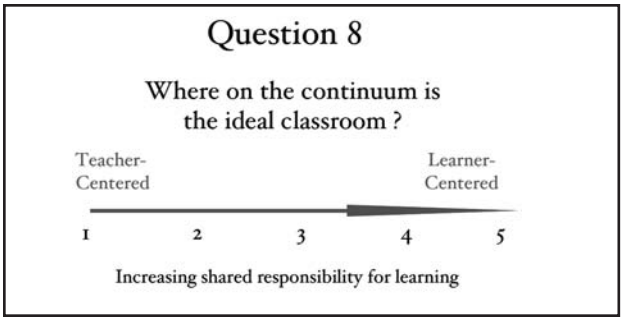
Q8: Where on the continuum is the ideal classroom.
(Scale 1-5: teacher-centered = 1, learner centered = 5)
Most respondents felt it should be learner centered.



What is the learner centered classroom? You need to define that.

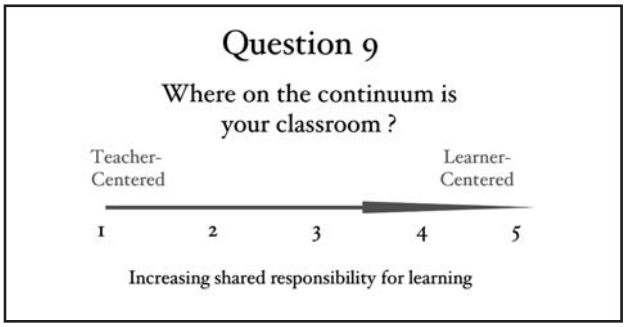
What is the difference between an engaged and disengaged classroom?

Participants were shown a series of slides with Karl Smith images of matter flowing into heads. The concept that we can "pour knowledge" into the "empty vessels" (students' heads) is fundamentally flawed. Students do not come to us as blank slates. They have many conceptions of how the world works, including many that are inaccurate. The slides illustrate how learning takes place.

- Students construct knowledge by doing something with the knowledge (e.g., inquiry).
- Students further construct knowledge by discussing it, solving problems with others (classroom social and behavioral).
- Cooperative learning is essential to a student centered, interactive classroom.

Q9: Where on the continuum is your classroom.
(Scale 1-5: teacher-centered = 1, learner centered = 5)

Respondents rated themselves primarily as teacher-centered in their classrooms in which students share little of the responsibility for learning other than taking notes and figuring out what they mean after class. Faculty have a difficult time giving up their role as the talking head in the front of the classroom because they truly believe that by their telling and explaining information, students will gain. In fact, data do not confirm this premise.



David: At NYU, at the start, the classes are teacher centered, but as the students move through school, they move toward a learner-centered classroom environment. When we start with learner-centered courses, we lose freshmen.

Diane: But I believe we have already lost them. See, for example, Talking about Leaving, an extensive study conducted by Seymour and Hewitt (1997) on why students leave science. We are losing the opportunity to educate a scientifically literate society, which should be a critical goal for this country.

David: Many who decide to leave general biology leave because they don't want to work.

Terri: The irony is that students go to political science and sociology. Their concept of biology has a lot to do with misconceptions they develop in high school.

Diane: Where do teachers get their degrees? In sciences, their science courses are taught in our departments.

Fred: I think the idea is embedded in high school. Students are turned off in taxonomy. Research is the fun part. So that's why we pull them in early.

Gene: I think it is very practical. A lot are pre-meds. When they realize they are not going to med school, they drop out of biology.

Diane: There is a real need for dissemination. We need to replicate what works. We are very interested in dissemination. We were talking about different things. What is needed is to disseminate substantive ideas that work.

How can we do faculty professional development?

FIRST II and other similar programs are examples.

How do young faculty deal with their teaching emphasis?

Diane: One of best things is co-teaching.

Nancy: Once you become tenure track, it is too late.

Terri: Graduate students don't want to participate in these kinds of programs.

Diane: Is that because they don't want to teach?

Terri: No. They don't want to take the time.

Adam: Reach faculty where they live. Invite experts in education to speak to your department, perhaps as part of a regular seminar, or to be a plenary speaker at a professional meeting.

Nancy: I am just coming off a four-year project. Even when faculty had excellent anatomy and physiology modules, they would not use the modules. They thought about content. They must build in ways for students to reflect on content.

Diane: We need to write about these things

John: There are many "how to" articles, but they mostly rely on anecdotal evidence. Faculty feel alienated by psychology journals if they lack credible evidence. But today we got to see the data. This was refreshing. I think what is needed are research articles that are acceptable, that are not loaded with jargon and are well supported.

Diane: I want to follow up with John. I want to talk about credible data. What do you think assessment is?
(Participant responses are listed below.)
1) Testing
2) Evaluation of mastery
3) Gathering data
4) Measure of the effectiveness of the teacher
5) Meeting goals of teacher
6) Formative and summative

Diane: What are these (points to large post-it notes)?
Audience: Formative

What is assessment?

What is assessment?

Data collection with the purpose of answering questions about…

- students' understanding
- students' attitudes
- students' skills
- instructional design and implementation
- curricular reform (at multiple grainsizes)

Why do assessment?

Why do assessment?

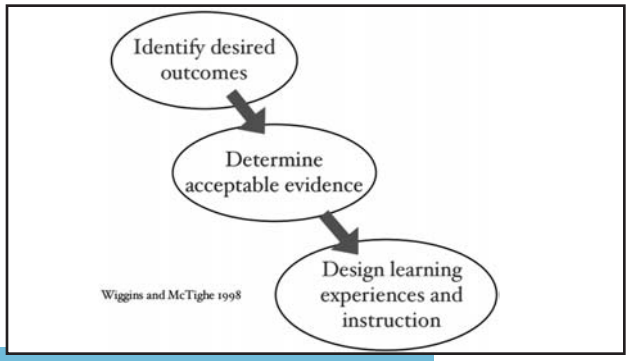
Improve student learning and development.

Provides students and faculty substantive feedback about student understanding.

Challenge to use disciplinary research strategies to assess learning.

Is the BS degree an assessment measure?

The following slide illustrates the processes assessment entails.



Q10: True or False? Assessing student learning in science parallels what scientists/psychologists do as researchers. Most respondents indicated "True." Indeed there are many parallels.

Parallel: ask questions

1. Description:

   -What is happening?

2. Cause:

   -Does 'x' (teaching strategy) affect 'y' (understanding)?

3. Process or mechanism:

Parallel: collect data

We collect data to *find out* what our students know.

Data helps us *understand* student thinking about concepts and content.

We use data to *guide decisions* about course/curriculum/innovative instruction

Parallel: analyze data

Quantitative data - statistical analysis

Qualitative data

break into manageable units and define coding categories

search for patterns, quantify

interpret and synthesize

Valid and repeatable measures

Parallel: peer review

Ideas and results are peer reviewed - formally and/or informally.

Session leader Ebert-May presented guidelines for thinking about research.

Guidelines for thinking about research…

What did students learn? (assessment data)

Why did students respond a particular way? (research) Significant question?

What are the working hypotheses? Relevant theory..

What has already been done? Literature says...

How and why select methods? Direct investigation...

How to analyze and interpret data?

What do the results mean? Coherent reasoning...

Are findings replicable and generalizable? Critique by peers...

Fred: The physical scientists have done a much better job than have the biologists. How many departments have adopted principles of learning in their teaching? Less than 10%. There are much deeper beliefs than we acknowledge. How do we reduce biology to principles? We need a lot of soul searching. We need to make it fun because students are flying away

Diane: This is important.

David: There is a misconception that they have to teach Campbell (a common biology textbook).

Diane: Graham Walker published a paper on how they went through that process of determining what to teach in introductory biology at MIT.

David: We are going through that right now.

Diane: I think that "teaching Campbell" is an excuse. But I also feel that people care.

Terri: I think it comes down to reward. But do I have the time to figure this out?

Larry: That is driven by money. It is now corporate.

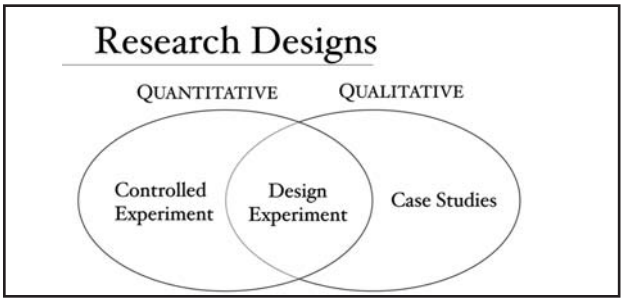
Diane: It is still points to the focus on the students. I am arguing that we can peck away at this. There are many people who are doing phenomenal things. Take, for example, student evaluation forms. If faculty teaching is evaluated solely by self-report student evaluations, the data are incomplete. Earlier we said that multiple forms of assessment are desirable. The criteria and format for evaluation of teaching needs to evolve. Student evaluation is just one piece of data. Analysis of course materials and classroom implementation are also important data.

Diane: In the FIRST project we are video taping.

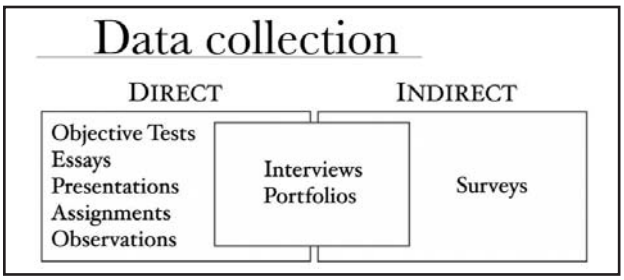
Question: Did it prepare you for future classes?

Diane: At the U of Minnesota, responses to Q7 centered at 2-3, so things are happening, people are changing.

There are several research designs we can use to design experiments.



In addition, we need to use evidence to show effectiveness of different methods and interventions.



Dave: There is a problem that we are avoiding. We are concerned that we will be criticized for grade inflation.

Diane: A study found that grades are not related to evaluations. It showed how to address grade inflation.

Julie: We are being asked to move to online courses.

Diane: We have very different goals for online courses. We need to identify the goals for online learning. Data must be aligned with goals.

Julie: I taught nursing online. I had one of the best experiences due to student involvement. I couldn't type fast enough.

Diane: You need to document your experience with this.

Pete: Did you see any of the students?

Julie: No I met them afterward, after the class

Time ended.

Recommendations

For Individual Campuses

- Faculty need to develop goals and objectives for their courses and curricula that can be assessed in multiple ways.
- Faculty need to become familiar with and understand the literature (and critical theories) about how people learn.
- Faculty need long-term professional development in assessment and research about learning.
- Faculty need to understand how to disseminate their findings about student learning within their professional publications.

For The Reinvention Center

- Faculty should form long-term networks and/or support groups (i.e., lab groups) to maintain, implement and advance discussion and implementation of changes in teaching intended to create active learning environments for all students.
- The Reinvention Center can provide assistance here.

Resources/References

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POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Ebert_May/Powerpoint.pdf

Breakout Session: Applying Principles of Learning in the Physical Sciences and Mathematics

Leaders: Robert Mathieu, Professor, Department of Astronomy, and Director, Center for the Integration of Research, Teaching, and Learning (CIRTL), University of Wisconsin–Madison, and Marilla Svinicki, Associate Professor, Department of Educational Psychology, and Director, Center for Teaching Effectiveness, University of Texas at Austin
Recorder: Shihmei Barger, Diversity Institute Postdoctoral Scholar, Center for the Integration of Research, Teaching, and Learning, University of Wisconsin–Madison

Opening Remarks

Mathieu: Welcome! My name is Bob Mathieu, and I am a professor of astronomy at the University of Wisconsin–Madison. I'd like to introduce Marilla Svinicki, a professor of educational psychology at the University of Texas, and Shihmei Barger, who just recently earned her PhD in higher education from the University of Wisconsin. We are all part of an NSF Center for Learning and Teaching called the "Center for the Integration of Research, Teaching, and Learning" (CIRTL), a collaboration of the University of Wisconsin, Michigan State and Penn State. Very briefly, this center is about research universities preparing STEM graduate students to be both superb researchers and excellent teachers. I don't know about your experiences, but as a graduate student at Berkeley I was primarily taught how to do research very well. Then when I showed up at the University of Wisconsin as a professor and walked into my first class I had little preparation for it, other than many years of observation as a student and my TA experiences back at Berkeley, which were largely unmentored at that.

The foundational hypothesis of CIRTL is that superb research and excellent teaching are not orthogonal aims. Our goal in CIRTL is to see if we can integrate the two through STEM faculty – present and future - incorporating their research skills into the advancement of their teaching, something we call "Teaching-as-Research." Our prototype programs have been in place at the University of Wisconsin for the past year, with nearly 300 participants. These are undergoing extensive evaluation, with the intent of further developing and incorporating what we have learned within a "CIRTL Network" of 10 research universities. The network development has already begun with activities at Michigan State and Penn State, and will expand to other research universities in the coming year.

In many ways, our motivations are the same as that of the Reinvention Center and this meeting: 33% of undergraduate students get their degrees from research institutions and about 80% of PhDs are trained at 100 universities. The latter is an incredible leverage point, since after graduation these STEM PhDs will spread out to over 4,000 institutions. The period when everyone is collected together at research universities is a key time to prepare them to be effective teachers, and to use their research skills to advance their teaching throughout their careers. This is the core strategy of CIRTL.

But we're here today for a different reason. You just heard two hours of educational psychology. The question now is what does this have to do with us and our classrooms? Let's start by going around the room and introducing ourselves. Then Marilla will speak for 15-20 minutes. Marilla will take the present knowledge on learning and, shall we say, translate it into a language that we can employ or use a bit more. After that we'll discuss specific problems in our classrooms and possible strategies for solving them.

Presentation

The presentation addresses the application of principles of learning to undergraduate physical sciences and mathematics classrooms. Four key concepts of learning are considered: 1) The role of prior knowledge, 2) beliefs about "knowing" and "learning" science, 3) affective differences, and 4) coping with too much, too fast.

1. The Role of Prior Knowledge

The key to learning is making connections: Connections between what you know and what you are being taught, what you hear in one class and what you hear in another, what you learn in one unit and what you learn in the next. Learning is the process of making these connections.

The quality of a student's prior knowledge has a tremendous influence on how much he or she can learn in class. When designing instruction, one should consider the following four questions about your students' prior knowledge:

1. What breadth and depth of prior knowledge do your students have?
2. Do they understand where your discipline fits in with all the other disciplines which they are taking classes?
3. How much do they know about the other related disciplines?
4. What kind of connections do they have to make between what you are teaching and those other disciplines in order to succeed in learning your class?

A critical aspect of learning is the depth of knowledge gained. Does the student have sufficient understanding of what has been taught to make connections between ideas and across disciplines? Is the student able to produce examples, make analogies, and apply information? How deep is the student's current knowledge, and what is the depth of knowledge for which you are aiming?

Accuracy of prior knowledge is also important. Many students come to science classes with misconceptions about how the world works. By thinking about these misconceptions you can address them in your instruction. They can even trigger students to want to learn. You can, for example, set up an experiment, have students make a prediction, and then ask the students to explain what happened in terms of their prediction.

Finally, there is variability of prior knowledge among learners. Students come to class with a wide range of backgrounds. It is important for you to assess the extent of variability and, depending on the situation, either bring everybody up to speed in class or give those students who are not up to speed background information and assignments that they can work on outside of class.

2. Beliefs about "Knowing" and "Learning" Science

All of us have different beliefs about what constitutes learning. Many students, for example, believe in "the certainty of knowledge:" there is one right answer, the instructor always has the right answer, and the student's job is to learn that answer. Students with this type of belief

will wait to hear the "truth" from the instructor rather than trying to figure it out for themselves.

Another belief about learning relates to how rapidly it occurs. Some students believe that learning must be instantaneous or it will not happen at all. They see their instructors solve problems instantly and respond to questions immediately. If they themselves do not understand something right away, they say "I can't do that."

Skepticism, a willingness to deal with less than perfect knowledge, the ability to withhold judgment, and the willingness to take risks are some of the attitudes about learning that students need in order to do higher level work. To teach critical thinking we must understand the beliefs our students harbor about our discipline, science, learning, and themselves as learners and respond accordingly.

3. Affective Differences

Affective differences refer to differences in motivation and emotional response. The most common form is anxiety—test anxiety, math anxiety, phobias about science. Other differences include motivation—one's willingness to learn—and volition—one's willingness to continue trying to learn in the face of not understanding. Students have different levels of motivation, which impact their willingness to tackle difficult problems.

By understanding affective differences, instructors can create classroom environments that help students overcome them. Discrepancies between a student's performance in class and on exams, for example, could be due to test anxiety; by increasing the frequency of exams and lowering the stakes for a given exam, an instructor can help students grow accustomed to taking exams and reduce the anxiety. To assist students with math or science phobias, instructors can structure situations so that students have a high probability of succeeding at challenging tasks, and thus help to rid them of those phobias.

4. Coping with Too Much, Too Fast

Every faculty member at a university has to deal with students having to learn "too much, too fast." One way to help students cope with this difficulty is through structural understanding; that is, by providing experiences that enable them to gain understanding of the structure of the discipline, without necessarily knowing all the details. If students understand the structure of the discipline, they can reproduce information without having to memorize the details. They can even speculate on details based on what they know about the structure.

We produce structural understanding through visualization (e.g., concept maps, outlines, flow charts, hierarchical structures), by how we organize the course, and by asking our students to take an active role in organizing information with us. If students can understand the structure, it is easier for them to learn the information, since they have something to attach it to.

Discussion

Are there different learning styles?

Question: Could variability across learners be due to different learning styles rather than different backgrounds?

Svinicki: There are few data to support the notion of the existence of identifiable learning styles. Learning styles is a problem of definition, it's a problem of instrumentation, it's a problem of reliability and validity of the instruments, and the constructs are very difficult to pin down. However, there are some learning preferences. So, for example, the one preference that really has some support in the literature is a global processor versus a sequential processor. A global processor needs to see the whole thing first and then go in and fill in the details. A sequential processor wants the step-by-step building to a climax. Here's the bottom line on that: global processors cannot deal with a stepped presentation of material, but sequential processors are not harmed by going global first. So, the thing to do is to present a global overview first and then go back and do the steps, because then you have both.

Question: So does that tell us that there really are learning styles?

Svinicki: Most psychologists believe there are differences among learners, so we talk about it as individual differences amongst learners. There we can demonstrate differences. Prior knowledge has a tremendous impact on individual differences in learning, and beliefs about learning have a tremendous impact on one's motivation. These are things that really make a difference, but in terms of an identifiable set of learning styles, I'm just telling you that, as a researcher, I don't trust the data, and neither does anybody else.

Learning versus Studying

Question: I'm curious about the language we are using here. We keep saying "learning." I'm wondering why we don't use "studying"?

Svinicki: Because we're talking about an underlying phenomenon that is a permanent change in behavior, not the behavior that produces that phenomenon. Studying is a behavior that produces learning, and learning is the underlying phenomenon that changes behavior. That's the difference between the two. Knowing is the result of learning. In other words, I know something, I've learned it, and I can demonstrate I know it by being able to tell you what it is.

Question: But do you change your behavior by learning?

Svinicki: Yes. And the behavior you change is knowing.

Comment: So studying is a way of learning. Studying is an external manifestation of a behavior that should result in learning, which should result in knowledge or understanding.

Motivating Students to Learn

Question: What can we do to motivate students to learn?

Svinicki: You want to get students to be mastery oriented. First, create a safe environment in your class where students are willing to take risks: you praise or recognize effort and risk taking, you minimize risk by having students work in pairs or groups before they work individually, and you model good motivated learning. For example, the best thing that could happen to you in your class is to have a student ask you a question that you can't answer, because that's an opportunity for you to model "what does it mean not to know something" and "what do we do with it." Instead of saying, "I don't know the answer to that," it would be better to say, "Wow, I don't know the answer to that. Let's think about it. What you're asking is such and such. So what I'm thinking is, is this related to that? Well, no, but…" You're modeling thinking— and you're modeling not falling apart when somebody asks you a question.

Second, increase your students' self-efficacy; that is, help them expect to succeed. How do you do that? You test them slightly above where they are right now so it's a challenge, but doable. You pick tasks that they don't know the answer to, but they have enough to be able to figure it out and then you teach them how to figure it out. If you don't like self-efficacy, go for expectancy for success. You create an environment

in your classroom where they're expected to succeed. You act like they think they can do it and you teach them that they actually can do it.

Finally, engage them in tasks that have value, especially immediate utility value. In other words, they need to do this in order to do something that's next or you help them make the connection between what they're learning now and what they're going to learn next semester or down the line. Making the connections between what you're doing in class and what they experience in the everyday world really raises motivations.

Course Outlines for Students

Question: After Mark McDaniel's talk, I started to feel that my practice of providing students with an outline of a chapter was unproductive. But then you say I should provide them with structural context within which to place their learning, which was my idea behind giving them the outline in the first place, knowing that most of them don't get the textbook and the rest don't read it—at least they have an outline.

Svinicki: Are you working with novices or students with prior knowledge? If you are working with complex information and novices, you need to provide some structure, because they can't do it themselves. I know some people really like inquiry learning—and so do I—but inquiry learning requires some structure if you have total novices. However, it is bad for student learning to give them complete notes because the action of creating your own examples, of synthesizing what someone has said, of paraphrasing what someone has said, is part of that elaborative rehearsal that McDaniel was talking about.

The problem, of course, is that we go so fast sometimes that our students don't have time to do anything other than copy down exactly what we said. If you are dealing with novices in an introductory course, it is a really good idea to have an over-structure that they can work with—like an outline, but not filled in. It's a really good idea for them to have that during lecture, during class. It's also a really good idea to sometimes be quiet so they can actually write things down.

In fact, in my class—I teach undergraduate students as well as graduate students—I will say, 'Okay, I'm not going to say anything for a few minutes. I want you to just think about what we have been taking about, write some notes for yourself, think of some examples, and then if you want to, ask questions.' I know that there is some small percentage of my students who spend that time checking their e-mail or zoning out, but 80% of them are actually trying to think about what I just said. That's good enough for me; I'm willing to work with that 80%.

So, for novice learners: skeletal notes, time in class to process. For experienced learners, skeletal notes are not helpful, because if you have an experienced learner, they already have a mental model of the discipline, and if you try to force them into using your mental model it is just going to frustrate them. But if you just give your presentation and while you talk they are making comparisons, trying to make the connections with what they already know, how they think about things, that's really good active processing and they are going to get a lot more out of it. So what on the surface seems contradictory in reality is not; it depends on the structure of the content. If you have highly structured content, it's going to be easier for novices, but harder for more advanced learners.

Taking Notes in Class

Question: How do I keep my students from writing down every single word I say? You know, from being the stenographer to listening and processing. And is that something we want from our students?

Svinicki: I don't think you want your students to be scribes, but what they're doing…oh, you go ahead.

Comment: The way I've dealt with that is to keep the class notes on my class Web page.

Comment: Yes, but Marilla is telling us that's not the thing to do.

Svinicki: After the lecture, after the lecture.

Comment: What I tell them to do is to print the class notes before class and then write comments in the margins. The notes contain the equations and the derivations, so they're not trying to copy down numbers or formulas. They're more skeletal.

Svinicki: Similarly with diagrams. It's very hard for students to draw accurate diagrams. They would very much benefit from having the actual diagram to write on, like you were saying.

Why do students think they need to write down everything we say? The reason is they are offloading information to an external storage medium so they can consult it later. If your assessment strategy is going to require them to remember those exact details, then that is a very strategic thing for them to do.

Comment: Well, the information is all in the textbook.

Svinicki: But the textbook is really hard for a novice to process, unless you point to it and say 'this is on page such-and-such.'

In lecture, students always say, 'Can you repeat that?' and I say, 'Probably not.' You've got to convince your students that exact notes are not the way to go—by the way you ask your questions on exams, by the activities you have them do in class, by the way you have them do their homework. The exact notes are not the answer; the gist is the answer.

I don't know if any of you have a learning center on your campus, but they will suggest that for the first couple of lectures in the semester you show them the notes you would have taken if you were a student. In fact, you can even have your TA take notes on a transparency and then put the transparency up and say, 'Okay, here are the notes we would have taken. Now compare the notes you took with the notes we would have taken. You can see the kind of things we are intending to emphasize.'

Comment: I don't see the problem with notes. I think especially for a novice learner, if they are not buying the textbook and this is their exposure to the structure that they are going to have to work within, I think notes are helpful, as long as you provide the opportunity for them to process those notes in a productive way and in an interactive way. Especially if you have a bunch of novices in your class who don't come in with a whole lot of prior knowledge, writing things down is a good thing, provided you give them more opportunities to reflect upon that and to interact with that material.

Svinicki: Very nicely put. I agree with that. The important thing is to help them understand the end. I hate it when my students say the way they study is by recopying their notes so they are neater. I'm sorry, but that's not a good study technique.

Students and Textbooks

Comment: About this issue about not buying textbooks, if you don't have a textbook it is certainly a good idea to do your best to create one from the lecture material. But the student who makes the decision not to buy the textbook is starting from an immense disadvantage in the course. If students were having difficulty in my class because they didn't have a textbook, I wouldn't know how to start beyond telling them to buy the textbook. I would also say, if they have that textbook, they are at an advantage because they don't have to write down and reproduce everything that would be in a textbook. They can spend their time listening and assimilating, trying to figure out how this information fits into everything else they know, and building the structure, as opposed to trying to put down the information without understanding it and hoping that later on, on their own, they will be able to build a structure using that material.

Comment: I get concerned about people who write furiously during class, that they won't be thinking about what they are writing down as they do so.

Comment: So then you need to provide them with the opportunity to stop and think and not write anything on the board for a while. Even if they own the textbook and are transcribing everything you are writing on the board, I still think that's ok because it is a more concise version of what is in the text; you're giving them the opportunity to work with that material.

Svinicki: But you are going to have eight-to-ten years of habit to overcome. So spend time at the beginning of the semester trying to help the students understand that just because they have written it in their notes, that is not sufficient.

Too Much Content, Too Little Time

Question: I will ask a different question about what you commented on before: Too much and too fast. The area of mathematics, something like calculus, has been there a couple hundred years, and my colleague keeps telling me about what was happening 30-40 years ago. At that time, they probably covered the same amount of material and gave similar tests. What they are finding is that we keep cutting down the material we try to cover, we keep making our tests easier and easier, and so then do you value our education? The whole idea about education is, you try to use the shortest time to teach the students the most.

Svinicki: I'll give you my comments, but I think this is a topic that probably everyone in the room has thought about. The problem is that in the Renaissance, it was easier to be a 'Renaissance Man.' You can't do that anymore. We have exceeded the capacity of our students to learn.

Comment: I agree with that—that knowledge is exploding—but when I was in college, 5% of the population went to college and now 65% go to college. So, here is a question, and I don't know the answer: What fraction of the population can and should have a college degree? Part of what we are observing is some spread in a standard that cannot incorporate all of the population at the same level that we are used to teaching.

Svinicki: I agree with you on that, but that is a different issue from wanting to teach the same amount of ever-expanding material.

Comment: But if you taught the same amount of material that you were teaching 40 years ago to a larger part of the population, then you might run into the same problem. There may be multiple facets.

Comment: I would say the one thing that has changed with the students we see in mathematics is preparation. Something is happening in high school education that is not necessarily best for the student who is going on to college. It is being presented as 'this is what you need to know and I am preparing you and you are going to get good grades and pass the exams, and so forth,' but they are not being well served there. They are doing something, but it is not what they need to succeed in math courses. They are not prepared, we are still teaching at the same standard, and then we give a test and we cry when we feel like we have to adjust to the students.

Testing and Student Learning

Mathieu: You talk about students going forward in high school and maybe college, and learning how to pass the test. We've been talking about the fact that testing helps students to learn, but can you know whether students learn through testing?

Svinicki: That's a profound question.

Comment: I don't know the answer to that. Do I know if my students learn by giving them a test? I have no idea. How am I supposed to know that?

Svinicki: The difference between learning and performance is that learning is the underlying sub-strength that produces a change in behavior, but you don't necessarily see a change in behavior. There is this great thing in math called the buggy algorithm. For example, when subtracting two columns of numbers, a buggy algorithm is to always take the smaller number from the bigger number. And most of the time that will give you the right answer. But every now and then they will do it when it is not appropriate and all of a sudden their misunderstanding is exposed. So, I would say that testing may or may not tell you what they have learned. It has a lot to do with the relationship between the instruction and the test; that's why authentic testing is becoming more and more suggested.

Comment: Could you explain authentic testing?

Svinicki: Authentic testing is where the situation in which the performance is evaluated matches the situation in which the behavior would actually be used in the real world. So, for example, writing an essay is not an authentic behavior, but writing a letter or writing a column is. So performance tests that you do the in lab are more authentic than a multiple-choice test to gauge the ability to analyze a compound, because it is an actual demonstration of the performance. But even more authentic would be for your students to go out and do testing on the local water supply.

It somewhat depends on the purpose of the testing, too. If you look at the standardized exams all our high school kids take to get into college, it's pretty clear that if you go take a certain course you'll do much better on this test, not because you know the material, but because you get better at taking this particular test.

And we want our students to have that attitude of, 'well, I didn't do too well on the test, but I really learned a lot. I didn't get an 'A'—I got a 'C'—but I really learned a lot,' and to be happy with that instead of complaining about the test.

The Illusion of Knowing

Mathieu: Let me follow up on that, because I've had a long-standing question about this. You have all probably had this experience. They say, 'I really knew the stuff, but I didn't do well on the test,' and when you probe, they actually don't know the stuff. So, how do you get them to recognize whether they know the material or not?

Svinicki: Elizabeth Bjork talked about the illusion of knowing. Re-reading gives the illusion of knowing because you recognize it, but it isn't until you actually make an active attempt to use the information that you realize that you don't understand it. That's why having activities in class makes such a difference.

Comment: Actually, I get that a lot, so I always ask students to show how they studied for the test, and almost always they respond, 'Well, I read my notes and I read the textbook over and over again.' Then I ask if they did it properly, if they worked with the information. And they almost never have.

Comment: Going one step further, many of the textbooks now have student solution manuals that give you the numerical answer, but not the entire problem worked out. So if you assign ten problems for tomorrow, students will have done them, but what many of them do—as I have found upon asking them—is look at the problem and, after having read the chapter or not, say, 'Well, let's find out how it's done.' Then they find out how it's done. So what they learn how to do at the end of this process is understand the solutions.

Svinicki: There is some research to indicate that working through worked problems is one way of learning how to do it, but you've got to have that difficulty, that challenge.

Comment: Then they get the correct questions that are like that, but on every test I give, there are some questions that are not like that, but

based upon the same material that's in the book, and those are the ones they get wrong.

Svinicki: I have a confession to make: Psychologists have to take statistics, so I took lots of statistics classes, and nobody ever told me to work out the problems. As a good social scientist, I read the prose and skipped the problems. Well, somebody told me—like two years ago—that I should have skipped the prose and worked the problems. No one EVER told me that, and that's how I studied statistics—by reading the prose.

Comment: This refers to the definition of reading. When I was a student, my understanding of reading was to read the section, do all the problems, close the book, and work out everything. I think for lots of our students, reading to them means just moving your eyeballs through the material; it doesn't matter if it makes sense or not.

Svinicki: Absolutely. That's one of those beliefs about learning: If I read it I understand it, if I heard it I understand it, and, unfortunately, if I said it, I understand it, which is not necessarily the case either.

One of the other individual differences among learners is their strategies for learning; if they are new to a field, they don't have those efficient strategies. It really would behoove us to get them to understand what some of those strategies are, like close the book and try to repeat, or try to summarize what you just read and if you can't do it, go back and do it again. A belief about learning—instantaneous learning fallacy—is that if I don't get it immediately, I will never understand it, so I'm not going to try. So, yes, I agree that something that would really help our students is to tell them that in order to read a journal article you don't read it word for word all the way through; you read the conclusions first and then if you don't understand it, you go back and read. They don't know that. Where would they have heard that?

Giving Feedback

Mathieu: I'm changing the subject a bit. We heard five speakers today; is there anything that they said that you would disagree with and/or that surprised you?

Svinicki: At the end somebody asked a question about giving feedback, and the way it was described and the way it was interpreted gave me a sinking feeling. The way it was interpreted was that feedback is bad, and that is such a misinterpretation of that particular set of data. Feedback is not bad. Too much feedback is bad. Feedback that gives the student the answer rather than having the student work it out is bad. But not all feedback is bad.

Comment: So what's the right answer?

Svinicki: If you give constant feedback, the research shows that learners come to depend on the external feedback to evaluate their behavior, rather that learn how to evaluate their own behavior. The benefit comes from intermittent feedback that focuses on the difference between the student's answer and the real answer, and asking them to make that comparison. That's the way you should give feedback: it should be intermittent and it should focus on the misunderstanding, forcing students to examine their answers.

Comment: The image that came to mind during that discussion was teaching someone to play piano: you can sit there and interrupt them every time they play or you can have them play a phrase and say, 'now, let me play it and hear the difference.' But you can't keep picking at every single note, and so there is some Goldilocks principle that is going one here. I think feedback is important, but not in every single note.

Comment: I am interested in how active and passive learning plays into a whole lot of these things, from changes over time to what you were saying. It seems to me like he was describing active reading, and it seems like, to some extent, that if we provide constant feedback, we turn the exercise into a passive one. If we provide intermittent feedback, we make this an active process. That is the whole process of teaching, to try to do things that keep what the student is doing active. Everything that we do too much—providing notes that they can only read—is making it more passive, and that is just exactly what we shouldn't be doing.

Svinicki: That's it! The important thing is making the learning active—productively active. So just doing things to be doing them is not, but doing things that force you to think about what you are doing, that's when learning occurs.

Comment: I've heard a tennis analogy: By giving incremental advice, you can improve the swing, and eventually the person will have the very best bad swing that you can get. So somehow or another, the coach or someone has to tell them to get out of that and get into a different rut, if you will, and then improve. If all you do is incremental and not make a quantum jump at some point, you improve but only to a certain point.

Svinicki: I think that's absolutely right because our goal is to create self-regulated learners—learners who know how to approach a problem, know what their strengths are, know what some alternative strategies are, when to use one strategy versus another, what to do if nothing works, what are their resources—because that is what we all do. If somebody comes in and says, 'Hey, this didn't work,' we know what to do, but they don't. So what we are trying to do is teach them how to analyze their swing and say, 'well, the ball went that way and I thought I was aiming that way!' So what did you do? You swung too soon.

One of the cool things we have at our disposal now is instrumentation that allows students to review their behavior more readily. Video or computers analyze your swing and show that if you drop your elbow, you'll get this result. One of the things about computer-based learning is that it can track what the student is doing from minute to minute and then do a little analysis and say, 'You know what? They never do this step.'

Motivating Students

Comment: You gave these four different motivations that students have in courses, and only one of them I think all of us would agree is the motivation we want them to have, which is that they truly wish to master the material. I want to know if there is anything we can do as mentors/teachers to change the students' three bad motivations into the one good one.

Svinicki: First, I have to correct a misconception. We used to think there was a difference between students who wanted to learn and students who just wanted to get the answer right, and that one was good and the other bad. Well, it's never that simple. Now we've got students who want to learn—students who want to appear competent—so therefore are willing to do things to appear competent. Then we have students who want to avoid looking stupid, so they don't take risks. And then we've got those slackers. It's called mastery learning, performance approach, performance avoidance, and work avoidance. The performance approach goal is an okay goal, too. It is sort of like doing things for the wrong reason, but you're going to do them anyway.

Comment: So how can you turn performance avoidance into a performance approach? Are there things that we can do to encourage performance approach students to become mastery students? But the slackers, perhaps we're just going to ignore those; they're the 20% who look at their cell phone when they are supposed to be talking about their paper. And then the performance avoidance ones, maybe we can get the performance avoidance ones to become the performance approach ones, and the performance approach ones to become the mastery students.

Svinicki: You're on the cutting edge of psychology! That is exactly where we are right now in the research. I have a graduate student who's working on that. Remember what I said before about making the learning environment safe? We think that shifts everyone one over, but we don't want to move the work avoiders to performance avoidance, we want them at least at performance approach. Here is a research project

that I am doing this very moment: I believe that learning communities—building communities—create a safe environment, which allows students to adopt mastery goals in class, especially if you do things that improve self-efficacy. So the combination of a safe environment and self-efficacy should produce mastery goals.

Comment: I know Rochester is doing work on peer instruction. What they found is that with a workshop program, where you have peer instruction instead of faculty running tutorials, the students move up along the spectrum.

Svinicki: I think it has to do with the learning community. Everybody is learning at the same time.

Comment: I think that it is really more goal oriented. I mean, my perception from teaching introductory students in a non-major course—where I have business majors and art students who have no earthly benefit to them or their careers in taking a natural science course, but they are required to do so for the core curriculum—for those students, there are mainly two reasons they perform. One is the grade itself, and the other is they want to see some personal benefit and for their long term goals. That is the challenge in teaching introductory science: you have to make it relevant to them; even though you are not going to be scientists, it is important to learn.

Dealing with Misconceptions

Mathieu: I want to go back to what you said about having peer instructors and creating a safe environment. One of my concerns, and this comes out of some of the physics education research, is that those peer instructors are not good at addressing misconceptions and they are going to get in a rut and keep having a bad swing. Let's switch gears and talk about the misconceptions. One approach talked about this morning was using the clickers, but I am wondering if you have other strategies that we could use, and some thoughts on how you could encourage other faculty to spend their time identifying those misconceptions because I think that's the real key.

Question: What is the difference between a misconception and a preconception?

Svinicki: Preconception is something you believe before you learn; misconception is something you believe that is contrary to reality. The preconception could be right or wrong. The problem when you are dealing with misconceptions is that you are actually trying to get your students to engage in conceptual change, which is much more difficult than just learning the first time, because for conceptual change to occur, first you have to convince them that they are not satisfied with their preconceived notions. That is why I saw a lot of head nodding when I said the first thing you do is set up an experiment and you force them to make a predictions because when they make a prediction they have made their conception—mis or whatever—public or articulated. If the data then disconfirm that prediction, they are dissatisfied with their belief and they are vulnerable. We call it a "teachable moment." They are vulnerable to learning something new. The next thing that has to happen is they have to understand what the alternatives are because sometimes we give them an alternative and they go, 'What?' They have to think that the alternative is going to be better than the alternative that they've got already. Then it's going to be consistent with their other beliefs.

So, the idea about misconceptions is conceptual change you engage in when you are changing students' conceptions. Now, how do you identify those? This is one of those "you are the expert and you have to know." I am about to give you jargon—"pedagogical content knowledge." I think the only way to do that is for the learning community of a discipline to recognize what the common misconceptions are, because there is just no way for you as an individual to know all of the misconceptions that your students are likely to have. But if you've taught a class three or four times, you know they are going to have problems with this issue and that. In psychology, we would put up a survey and say, 'Do you believe this? Do you believe that?' Then you force them to make a statement and you go through and ask them why they think that and then give them the reality.

Comment: I have a different way of looking at misconceptions. It may be that everything we think we know is currently a misconception, and students have misconceptions that we already have data to suggest are incorrect. I don't really have a problem with my students who have misconceptions because I can say to them that the things we have measured up to this point no longer support that idea. Therefore, we think this is the better interpretation, but I also recognize that this is our best interpretation based on what we know right now.

If you think about students misconceptions and what we have to do is address those misconceptions, then we are starting to teach them a way to think about science that we don't want them to be thinking about necessarily; that is, there is a right answer and I know the right answer, and you need to get the right answer from me. Even though a lot of the issues you raised today are things that I see as problems in the classroom, one that has never—in thirteen years of teaching—seemed to be a problem to me is that they have a lack of knowledge and all these misconceptions, but we can adjust that at least up to my level of misconception.

Grades and Student Learning

Mathieu: I'd like to ask a different question, something I am curious about: What is the effect and the role that grades play on student learning these days. If we have a graded course or a non-graded course, how does it affect behavior and motivation, independent of our need to identify students for graduate schools.

Svinicki: I don't have a data-based answer for that, but I have a theoretically-based answer. Theoretically, grades that are based on norm-referenced grading develop performance orientation motivation, such that the grade becomes the evidence of proficiency and the learning is kind of irrelevant. So when you use norm-reference grading, you move students away from mastery orientation towards some performance—and it may be performance avoidance, or it might be performance approach, it really depends. I would say that grades, if we are trying to use grades as feedback, are an awfully blunt instrument for the subtle changes that take place in learning, and they are not a particularly reliable measure, so the feedback is going to become suspect anyway.

I prefer performance criteria reference grading because it sets a standard that students need to reach and it becomes a motivator towards achieving that standard rather than beating out everybody else. It allows me, as the teacher, to be a collaborator with the student to get to that grade, to that performance. That makes it easier for me to support students who are making mistakes because when students make mistakes in a graded situation they're often reluctant to show their mistakes because they are being evaluated. But if I am a collaborator with them, then they are more willing to tell me that they didn't understand. Grades as we use them now are very blunt instruments that don't tell us a lot and may push our students towards performance orientation, which is not a motivational stance that I would want them to take.

Comment: Twenty years ago there were a number of universities that went away from lettered grades, and they have all gone back.

Svinicki: They have all gone back, but it is because of external pressures. It really has nothing to do with the grading itself.

Comment: But it had no effect on students' ability to learn.

Svinicki: It could have an obstructionist effect on the students. If they are so focused on the task or the grade, then they are not willing to show their mistakes and they are not willing to take risks. There is a

difference between grading and assessing. I am a big believer in assessing learning and giving appropriate feedback to students based on that assessment; I sure would be happy if that was all I had to do.

Mathieu: I went to criteria grading two or three years ago and it has had an interesting institutional effect. When you set down criteria, the students strive towards them. They will strive, they will do the extra credit challenges—which are difficult in my class—to get that 'A.' Now maybe that's performance or maybe that's imaginative learning, but from an institutional point of view, most institutions don't want to see GPA's for your classes that are 3.5, 3.7, especially if you're coming up for tenure or promotion: " you just got good reviews because you give out high grades." I personally don't have to worry about that anymore, but when I speak to young faculty it is really an issue to be considered in their approach to teaching.

Comment: Having taught classes with pass/fail grades and regular grades, I abhor pass/fail because I feel like it encourages nothing out of my students. There is no reward, so there is no reason to perform. Unless the bar is set so high for the pass that you're now doing the performance approach. I like this idea of criteria grading, though.

Mathieu: The reason I originally went to criteria grading is because I switched to collaborative learning. Art Ellis, a chemist, convinced me that if we are going to promote collaborative learning, we can't have students competing with one another for the curve. I started setting down very specific grade levels. Of course, the first time you do it is scary because you don't really know how it is going to go. But I've done it a few years now and I have found that no matter how I ratcheted it up, the students strived and worked harder than students in my other classes to get over that top bar. I assume the reason they do it is not simply a desire to learn. But I have seen my students do things that I have had other faculty tell me that they could not do.

Question: Can you give us an example?

Mathieu: I have art students doing the square root of *n* statistics in my Introduction to Astronomy course. One of the most important topics is accuracy and precision and certainty—I think those are fundamental "ways of knowing" issues. Never in a million years did I think I could talk to these students about standard deviations and computing Poisson statistics. We certainly never would have touched that before. As another example, I've started having extra credit problems. An example: Here is a time sequence of the solar wind; create an experiment to explain where the solar wind comes from. Now, understand that in the lab they had seen SOHO pictures of the sun and they had done the rotation of the sun the same way Galileo did. I have students in there looking at the x-ray images and seeing these magnetic fields coming out of the sun spots and they are trying to correlate the solar wind peaks with magnetic fields on the sun. I didn't tell them anything, I just told them to create an experiment and execute it for three points extra credit. And they are doing good work. I never thought my "non-science" students could do work at this level.

Question: Have the students who decided to take the class changed?

Mathieu: No, because most of the students who are taking this class are doing so to fulfill a general education requirement.

Comment: I use the same sort of grading scale in organic chemistry. What you see is the students really wanting to understand the material and collaborate with one another. One of the interesting things is I don't hand out means of the exams anymore because the students are not competing with one another; it doesn't matter how they did compared to everybody else in the class. The only comparison they have to make is to this absolute curve that you set on day one. It is a shift in their understanding of the whole grading process, and they talk to one another much more. My guys get together on-line on Sunday nights for two hours to work on these collaborative quizzes. And it doesn't matter who is contributing; nobody is holding back because they are not competing against one another now.

Mathieu: Isn't it something to see them talking to one another about chemistry?

Comment: Absolutely.

Mathieu: What really started me thinking about this was a conversation at a family dinner with a guest who had a daughter who was a student at UW–Madison. She said 'my daughter got a 50% on a quiz and it was a 'C'.' So we started talking about curves and she wanted to know why we used curves, and why we curved if the students weren't achieving. I went through the whole rigamarole that I believed at the time, which was that I couldn't set absolute standards for them because I didn't know in advance how they were going to perform. So the curve was the natural way to self-calibrate the students with one another. That was the fiction that I had been telling myself for 15 years.

Comment: But you can correct the curve. You are able to adjust it, so if you see that everyone is doing poorly because you blew it on one test, there are lots of ways to adjust for that.

Svinicki: I have to tell you about something that happened in my class. I do criteria and reference grading, too and on one test a couple of semesters ago they really blew it on one question. I was just devastated because I didn't get how they didn't understand it. I went into class and said, 'You know, most people didn't get any credit on this question and this is important, so I want you to take the test back, do the question again, and you can earn back half the points that you lost.' Which then of course I had to grade again, but that's okay because at least this time they were getting it right because they could work together. One student brought her test back and she handed it to me and she said, 'you really do care if I learn this, don't you?' And I said, 'Yes, I do!' It was a really interesting experience, changing the students' view of the test into a learning experience, as opposed to an obstacle to get over.

Mathieu: It's 5:30, so I'm going to close with what I hope is a heart-warming thought. It is an answer to your question about the students who are in there and don't see any relevance to it. I find it incredibly motivating for my students when I tell them that the most important thing to me is that ten years from now they be able to teach their children this idea, and I tell them stories about how I teach my children from what I learned in my college courses, so it becomes very real. I find that very often this changes their whole perception of whether it matters or not. Otherwise, what difference do the stars make, or the rocks, or so on? But I tell them that when I walked through California with my kids I was able to tell them the stories of the rocks from my college geology class. And my students buy into that—not all of them, obviously—but many of them buy into that motivation for learning.

Recommendations

- Learning theory has much to offer to help faculty understand principles of effective teaching and student learning that they can draw on in their own teaching. Many of the behaviors exhibited by faculty with respect to teaching and learning mirror the novice behavior of the students in their courses. These include wanting to know "the answers," needing concrete examples, discomfort with uncertainty and incomplete knowledge, and a disinclination to go to abstract levels. Acknowledging and building on existing behaviors, with the goal of modifying that deter learning, should be an integral part of designing professional development programs.
- "Criterion-based grading" is strongly recommended over "norm-based grading," in that the former promotes attainable success with investment, self-efficacy, a safe environment for being wrong and taking risks, and collaborative learning.

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Mathieu_Svinicki/Powerpoint.pdf

Breakout Session: Interdisciplinary Programs: Integrating Different Perspectives and Ways of Thinking into Undergraduate Education

Leader: Ellen Yi-Luen Do, Associate Professor, School of Architecture, Carnegie Mellon University
Recorder: Ken Camarata, Graduate Student, School of Architecture, Carnegie Mellon University

"A researcher is: curious, patient, sees or seeks causality, systematic, playful, daring, creative, persistent, a critical thinker, open minded, analytical, passionate, thick skinned, a conceptual modeler, honest, hard working, willing to collaborate, and questioning."
- session participants

Presentation

This session explored creative ways to integrate interdisciplinary research in the arts, humanities, science and engineering to foster the spirit of inquiry in undergraduate teaching. Different perspectives and ways of thinking derive from qualities of researchers in scientific and creative inquiry; bringing them together enriches student learning by encouraging both teamwork collaborations and independent thinking.

The session started with the presentation of, "Visual Thinking and Spatial Reasoning" (http://www.andrew.cmu.edu/user/ellendo/0.reinvention/0.default.html, PDF available at http://www.andrew.cmu.edu/user/ellendo/reinvention.pdf), an inquiry-based interdisciplinary freshman course session leader Do developed and taught while at the University of Washington. The course engages students from diverse disciplines in hands-on exercises and group activities in order to encourage creative thinking and exploring ideas. The presentation was followed by a conversation about fostering the qualities of a researcher in undergraduate students. Participants shared teaching ideas and openly discussed the barriers. Collectively, they recommend creating a voice for the growing community of educators who seek to foster future researchers, and reforming the faculty reward system so that interdisciplinary research and teaching (and the planning work it requires) holds value in the promotion and tenure process.

Session leader Do's course on "Visual Thinking and Spatial Reasoning" course (http://depts.washington.edu/visual, also available at http://code.arc.cmu.edu/visual) consists of a series of learning modules, each devoted to a different topic and examined from multiple perspectives. Daily exercises and weekly projects for each learning module (or topic) introduce ideas, offer opportunities for students to personalize their learning experience, and encourage inquiry. Frequent writing and individual portfolios facilitate self-evaluation and offer students opportunities to reflect and respond to topics and questions embedded in the "hands-on" exercises.

Topics such as "Geometry and Engineering" as well as "Function and Form" allow for a wide range of engaging activities. Students become immersed in a world of origami, puzzle solving, and pop-up books and they design paper airplanes, automata, and cardboard furniture. The origami exercises introduce procedure, geometry, and collaboration. Coupled with foundational readings and exercises in diagramming the process, origami also helps students understand concepts in mathematics, creativity, and communication. All of the course exercises are followed by thematic research papers that introduce related scientific and creative inquiry. In the spirit of Leonardo DaVinci, the course blurs the artificial divide between arts and sciences.

Discussion

The discussion was organized around three questions:

- What qualities make a researcher?
- Can you suggest an exercise in your discipline that promotes one of these traits?
- What problems or challenges should the Reinvention Center tackle?

Whether in the arts or sciences, good researchers share certain qualities, such as a drive to seek causality, a need to address problems systematically, and a sense of playfulness. These qualities are valued by people performing successful rigorous research in both scientific and creative inquiry. Courses that cultivate the qualities of a researcher will benefit from embracing both. New courses should be designed to develop and cultivate these qualities.

The enthusiasm evidenced by participants in sharing creative teaching ideas suggests that, as we design courses to cultivate the qualities of a researcher, having mechanisms for disseminating successful teaching ideas would be of value. Logical thinking, observation, and causal reasoning are important skills used by researchers. The following playful examples highlight these skills and hint at the rich body of educational knowledge that could be shared.

- What's in the Box? A chemist suggested giving students a sealed box and asking them to guess its contents. Systematic interaction with the box provides clues to the object inside.
- Interpreting the Box. A painting instructor carries around a bag with an object inside. Students reach in and touch the object, but are forbidden to remove it or look into the bag. They are then asked to make a painting that uses the object as a dominant element.
- Breaking the Box. A materials scientist described a common method within his discipline as "breaking stuff and making observations about how it broke." With a little creative thinking, this idea can be applied to many different disciplines and can motivate student involvement.

The group concluded that designing interdisciplinary courses that cultivate the qualities of successful researchers should play a critical role in undergraduate education. Unfortunately, the current academic environment contains barriers to achieving this goal. The successful integration of the ideas and values expressed in this session are going to require the integration of different perspectives and ways of thinking in the way we manage the academic environment.

1) Researchers, whether in the arts or sciences, share certain qualities such as a compulsion for "seeking causality," a need for "systematic" investigation and a sense of "playfulness."
2) These qualities are valued by people performing successful rigorous research in both scientific and creative inquiry.
3) Design new courses to encourage thinking "outside and beyond the box."
4) Courses that cultivate the qualities of a researcher will benefit from embracing both the arts and sciences.

Recommendations

When asked to identify barriers to designing courses that foster the spirit of inquiry, session participants replied with clear ideas. The underlying theme was to find ways to give the idea currency within the university setting.

<u>For Individual Campuses</u>

- There was a consensus that the current system discriminates

against educators who focus on integrating interdisciplinary research into undergraduate teaching. Even with a peer-reviewed-journal in place, the current reward system for tenure and promotion places little value on it. Campuses need to reform their existing faculty reward system so that developing interdisciplinary research teaching holds value in the promotion and tenure process.

- Campuses should establish initiatives and programs to encourage educators to integrate research practice and methods into undergraduate teaching. Administrators should value undergraduate research education and the community of educators of such practice.

For The Reinvention Center

- There is a growing community of educators who are interested in integrating interdisciplinary experiences into undergraduate research education, but there are no clear venues for promoting this work. Participants want ways to post success stories, provide pointers to grant opportunities, and promote community values. The Reinvention Center should establish itself as a voice for this growing community which is interested in fostering future researchers.
- The Reinvention Center should sponsor a peer-reviewed journal that focuses on integrating interdisciplinary research in undergraduate education. This would allow people to learn from one another, and it would provide an opportunity for their success to count toward promotions and tenure.
- The Reinvention Center should compile and disseminate collections on teaching resources and grant opportunities.
- The Reinvention Center should sponsor workshops and presentations that promote the values of this growing community.

Resources/References

Websites

1. "Visual Thinking and Spatial Reasoning" Presentation http://www.andrew.cmu.edu/user/ellendo/0.reinvention/0.default.html and http://www.andrew.cmu.edu/user/ellendo/reinvention.pdf
2. "Visual Thinking and Spatial Reasoning" Course Information http://depts.washington.edu/visual and http://code.arc.cmu.edu/visual
3. The Computational Design Lab, School of Architecture, Carnegie Mellon University http://code.arc.cmu.edu/lab/html/

Plenary Session: Providing a Quality Research-Based Undergraduate Education: Critical Issues and Challenges of the Next Five Years

Challenges in STEM Education: Eleven Assertions

Moderator: Judith Ramaley, Assistant Director, Education and Human Resources, National Science Foundation, and President Designate, Winona State Univerity

1. The demography of this country is shifting dramatically toward a much more diverse nation. However, we have significant gaps in the participation and achievement of women and minorities in science, technology, engineering and mathematics (STEM) education and in many STEM professions. In addition, public understanding of science has never been more important and a facility with mathematics, technology and science is now essential for productivity in the workplace and good citizenship.

   As the opportunities for STEM professionals increase, we have not seen a comparable increase in enrollments. In fact, in some areas, such as mathematics, the enrollments are dropping. This problem will be exacerbated by the changing composition of our society. The participation of minorities and women in STEM professions is significantly less than that enjoyed by white males, especially in fields such as computer science, engineering, geosciences, mathematics and the physical sciences. We have become increasingly dependent upon attracting well-prepared international students to fill some of our most skilled science and engineering positions and to study in our graduate programs in these fields.

2. The pathways and options available to students have proliferated, but the resulting educational environment is complex, difficult to navigate and leads to fragmentation of experiences and goals. Our old assumptions about who our students are and why they choose to participate in higher education must be reexamined.

   As patterns of enrollment change, conditions within single institutions will no longer define the experience of a majority of undergraduates. We will need to think differently about what it will take to ensure a coherent and purposeful educational environment for all students. Few students of traditional age (18-26 years) now obtain their education from one institution.
   - 57% attend more than one school as undergraduates
   - 35% cross state lines to do so
   - 20% earn acceleration credits by examination or dual enrollment while in high school or in college
   - 62% attend during summer terms
   - 22% are drop-outs, and 14% are enrolled for less than a year

   The pathways that students take are increasingly complex.
   - 26% attend two or more 4-year schools
   - 9% transfer from 4-year to 2-year schools
   - 22% transfer from a 2-year to a 4-year school
   - 14% alternate between 2- and 4-year schools
   - 12% take a few community college credits in addition to attending a 4-year school
   - 11% attend two or more community colleges

   We have now pathways, not pipelines.
   - Pipeline: a clear and uninterrupted route from high school to college and from college to advanced study
   - Pathway: a complex pattern of enrollment that involves multiple institutions and either continuous or interrupted enrollment

3. The professoriate is also changing in significant ways. This will affect our ideas about the nature of an academic community and a community of scholars.

   According to the U.S. Department of Education, in 1987, 67% of faculty were full-time and 58% had tenure. In 2002, 55% were full-time and 45% had tenure. Full-time and tenure-track faculty are being replaced by part-time and fixed-term faculty. Part-time faculty primarily teach (89% of their time), while full-time faculty play more complex roles.

4. Too few teachers of science and math K-12 have adequate preparation and professional support to provide excellent instruction, and anticipated rates of retirement and the unacceptable loss of qualified teachers from the field (average turnover rate is about 5 years) prevents us from making much of a dent on the competencies of the teacher corps. This problem is linked to the fact that too few high school graduates are prepared to pursue the study of STEM fields at the postsecondary level.

5. The resources devoted to research on science and math learning and on educational improvement are woefully insufficient and as a result our country has very limited capacity to conduct rigorous education research and evaluation.

   In the face of a growing national need for research-based solutions to our educational challenges, we devote less than one-half of one percent of the resources invested in public education (K-20) to research on education. If we extend that argument to adults and their educational needs, the story is even worse. We know very little about how adults learn, develop expertise and remain skilled in a rapidly-changing, technology-driven society. We must at least aim for investing 2-3% of our resources in discovery, innovation and application of research to educational practice. At a time when we hear greater demands for scientifically based practice and accountability, we have very few investigators able to undertake this work. It is the unique responsibility of the NSF to invest in research capacity and the IDEAS and TOOLS that investigators will need to incorporate into their work.

6. We do not know much about why people choose the careers they do or the pathways they travel to prepare themselves and then to remain skilled and competitive. We also do not have the tools to model the dynamics of the nation's workforce or to predict changes in our overall capacity. In areas such as science and engineering, different observers disagree strongly—using the same data—about whether we will have a surplus of professionals, a significant shortfall and a resulting workforce crisis or a system that naturally and relatively easily adjusts to demand. (Too many, too few or just right).

7. The revolution in computing and Web-access will have profound effects on education.

   It is becoming clear that new uses of technology will not only promote learning, but may transform our educational practices and educational environments. This is especially well illustrated in recent studies of the changing nature of the digital divide and the societal impact of access to Web-based technologies. We are witnessing the emerging "social life of information," to use a phrase coined by John Seely Brown. When fully used, Cyberinfrastructure (CI) represents a suite of enabling tools essential to the study of complex systems and to the modeling of real-world behaviors of these systems for learning purposes. It includes collaboratory software, visualization tools, data-mining capacity and data management techniques and the support of geographically distributed sensing systems and observation sites that generate enormous amounts of data to be assimilated and interpreted using knowledge representation and manipulation software.

   - CI can be used to see into the classroom and to examine the pathways by which individual students explore ideas and acquire mastery of material. The challenges of an educational context open up new areas of research for the designers of CI and cyber-tools and often generates new research questions. It also permits investigators to deal with the enormous data sets created by multimedia observations of classrooms, individual student learning and scientific observations.
   - CI can help us teach difficult and important material and explore new research questions that require more sophisticated modeling, simulations and visualization. It allows us to examine continuous, dynamic, simultaneous, organic, interactive, conditional, heterogeneous, irregular, nonlinear, deep, multiple processes that are difficult to understand.
   - The use of cybertechnology holds up a mirror to our faculty and challenges them to revisit their own assumptions about their role in learning, their intentions and goals for themselves and for their students. It permits them to engage their students directly in exploring material in the ways of their disciplines. Instead of a faculty member assimilating and interpreting a field, the whole thought process is laid open and students gain more control over the subject matter.
   - The most powerful effect of cyber-experience may not be in the things people do on the Web or with broadband communication, but rather how they think and what they expect from education. People who innovate and create in cyberspace will not be likely to sit still, literally, for a lecture.

8. Many of our expectations for improvements in undergraduate education require transformational changes in our nation's educational institutions, both K-12 and higher education, as well as in informal science education, yet we know very little about the underlying processes of organizational change and the leadership of change or how to facilitate it. In addition, we have little time, resources or inclination or energy to undertake such transformational changes. It takes a long time to introduce meaningful change in education and we must provide for long-term investigation of these interventions and strategies.

9. We live in a period of rapid and complex socioeconomic change (Twigg, 1997; Twigg and Oblinger, 1996). Many of these forces will shape the educational landscape in ways that we are only just beginning to understand. They will affect what people need to learn, when they need to learn, and where and how they will learn.

10. The basic skills required for successful entry into the workforce and reasonable professional progress are more demanding than they were even a decade ago.

    In *The New Division of Labor. How Computers are Creating the Next Job Market (2004)*, Frank Levy and Richard Murnane argue that computers are a better solution than people when the problems can be described in a rules-based logic, a step-by-step manual that provides a procedure for any imaginable contingency. What a rules-based system cannot do, however, is deal with new problems that come up, problems unanticipated by the program of rules and most importantly, computers cannot capture the remarkable store of how-to or tacit knowledge that we all use daily but would have a lot of trouble articulating (pp. 18-19). As Levy and Murnane put it: "In the absence of predictability, the number of contingencies explodes as does the knowledge required to deal with them. The required rules are very hard to write" (p. 20). One wonders, in fact, if the rules underlying creativity and innovation can be written at all.

    With this set of distinctions in mind between the predictable and the unpredictable, Levy and Murnane go on to show how reading, writing and mathematics are essential for mastering tasks required for expert thinking and complex communication. I only wish they thought as highly of the other parts of a good liberal education---science, the social sciences, the arts.

What human beings can do is see patterns and make conceptual connections between a new unfamiliar context or challenge and more familiar ones. We use "case-based reasoning" to see similarities between a new problem and some relevant past experiences (p. 23). These elements—cognitive flexibility, creativity, knowledge transfers and adaptability -- are the new basic skills of an educated generation and represent the capacities that will be required to acquire a professional position. Even the new basic skills that should be acquired in K-12, as Murnane and Levy talk about them, require a solid knowledge of mathematics and reading skills, as well as the ability to work in groups and to make effective oral and written presentations, as well as the ability to use computers to carry out simple tasks (Murnane and Levy 1996).

The Greater Expectations National Panel Report calls for a practical liberal arts education in which college students will become intentional learners who can (a) adapt to new environments; (b) integrate knowledge from different sources; (c) continue learning throughout their lives; and (d) thrive in a complex world and who will be intentional learners and "self-educators."

- Empowered through the mastery of intellectual and practical skills
- Informed by knowledge about the natural and social worlds and about forms of inquiry basic to these studies
- Responsible for their personal actions and civic values

11. The role of the research university in society is undergoing significant changes which will be reflected in our structure, in the nature of our scholarship and in our relationships with society-at-large. We must explore how research opportunities for undergraduates address these issues.
    - To prepare students to be good citizens.
    - To foster and renew bonds of trust in the community (i.e. social capital) and use the neutrality of the campus to provide a common ground to explore community issues.
    - To create leadership development opportunities for students and to foster a commitment to social and civic responsibility.
    - To enhance the employability of graduates.
    - To promote deeper learning and advanced intellectual skills.
    - To play a role in creating the capacity of the community to work on complex societal problems and to develop an effective way for the campus to contribute to economic and community development with a genuine role for students.
    - To build a new kind of accountability and support for higher education.

Integration of Research and Education

The integration of research and education has become a powerful tool for preparing students for the responsibilities of the 21st century workplace and for the demands of effective citizenship and the exercise of social responsibility. We must integrate research experiences with a broader conception of what it means to be educated and link research opportunities as well as curricular designs that promote a mindset of informed and responsible decision-making together.

Our challenge is to examine research opportunities for undergraduates not only as a means to interest a select group of students in going on to advanced study, but also as a vital component of the educational environment for all students and a means to attain our expectations for our graduates.

There are at least four ways to interpret the idea of integration of research and education.

1) Whenever we invest in research capacity, we are creating an educational asset. This asset can be deployed in a number of ways: To provide research experiences for undergraduate students, high school students and K-12 teachers, and to promote public understanding of science, research and technology. In some instances, the research activities themselves can be designed in such a way that the general public can also contribute to the work, through gathering of observations and data.
2) The results of research on cognition, learning and development can be incorporated into educational practice to promote more effective approaches to teaching and learning. This can be most effectively accomplished when researchers and practitioners work together to define problems of special importance, gather data and interpret those data. This process of collaborative research also facilitates the application of research findings to practice, while making it possible for the realities of practice to challenge theory and define research goals. One necessary condition for the integration of knowledge about learning into education is the attitude of faculty and teachers toward the integration of research and education itself. Researchers must take education seriously, and educators must take research seriously.
3) In some instances, research can be incorporated into the design of educational experiences for all students, not just those who can be accommodated on a research team or in a field or laboratory research project. This can be done through such pedagogies as service-learning, inquiry-based learning, and project-based learning.
4) In all cases, a scientific mindset and an approach that promotes quantitative literacy can be introduced into the classroom so that students learn in a mode comparable to that employed by an investigator, even if the work they are doing is not an original contribution.

In our session this afternoon, we will explore the critical issues that we may face over the next five years as we seek to provide a quality research-based undergraduate education. Our goal is to think about the forces that are already reshaping our research universities. There are many such forces. To name a few:

- The rapidly changing state of knowledge.
- The increasing fluidity of disciplines, by which we mean the convergence and integration of fields, methodologies---a phenomenon rarely reflected in the design or content of the undergraduate curriculum.
- New technologies that create new opportunities and allow us to model, simulate, experiment in cyberspace, and support collaborative environments.
- New undergraduate populations.
- A rapidly changing professoriate.
- New expectations for college graduates and new demands in the workplace.

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Undergraduate Education and the Core of the Research University

Speaker: John Sexton, Benjamin F. Butler Professor of Law and President, New York University

On behalf of New York University let me say that we are grateful to the Reinvention Center for bringing us together—from varying vantage points and diverse institutions, but with a single goal: to help shape and enrich undergraduate education in the nation. Let me also express to my wonderful colleague, the tireless dean of NYU's College of Arts and Science, Matthew Santirocco, my special gratitude and affection. As you know, Matthew ably serves on the Executive Board of the Center and, I suspect, it is he who is responsible for your invitation to me.

Our charge in this session is to reflect upon the major forces reshaping the world in which our research universities operate, and to consider how we might position ourselves to respond to those forces. That charge compels us, I believe, to take both a step back and a step forward. We must step back to focus conceptually on our core: what are we—and what should we be—as research universities. Then, we must step forward to test candidly our ability to realize our aspirations in the face of challenges—internal and external—that already exist and that will develop in the years to come.

Today I will assert that there is value proposition in an integrated version of a research university which not only hosts but also embraces undergraduate education. In my view, this notion of a university is not simply an historical artifact but also an enterprise of deep importance, both intrinsically and instrumentally. I will contend that it is possible to seize this theoretical value proposition for our students and ourselves, even as we face the daunting challenges ahead.

The Research University

The core mission of the research university is the creation and sharing of knowledge: the wonderful task of expanding and deepening what we know, how deeply we know, and the number of those who know. In pursuit of this mission, the research university relies on various attributes, the most important of which are the processes of rigorous inquiry and reasoned skepticism, which in turn are based on articulable norms that are not fixed or given, but are themselves subject to reexamination and revision. In the best of our universities, faculty characteristically subject their own claims and the norms that govern their research to this process of critical reflection.

The research university is deeply committed to intellectual honesty, to pursuing leads where they go, and to engaging with and being persuaded (or at least persuadable) by others along the way. Our universities nurture the quest for truths both plain and complex, and especially those truths that disturb prevailing assumptions. Moreover, scholars in our universities are free (and hopefully more often than not encouraged) to pursue their own research agendas; in this regard, our universities play a very different role from corporate research centers, political think tanks, and even the best policy research institutes.The research university, so constituted, produces enormous—sometimes inestimable, and too frequently insufficiently appreciated—benefits for society. Thus, for example, it is fair to say that a significant part of the wealth of our nation increasingly comes from new ideas and innovations developed on our campuses. Our faculty generate insights and tools to guide monetary policy to shape more just and effective laws and policies. And, just as our nation's wealth and social well being spring from our campuses, so too does our health. Every year our doctors and scientists bring us miracle cures for diseases, both chronic and pervasive. And all of this is only part of the story. The quality of our society depends upon the historians, classicists, and philosophers who, among others, bring the wisdom and insights of the ages to bear on the questions of our day – and upon our scholarly reflections on how to shape the professions and their products. Moreover, at our great universities we sustain the wonderful artistic acts, from poetry to symphony to palette, from the recording studio to the stage, that lift us to another dimension. In short, the research university is nothing less than the celebration, continuation, and expansion of what defines us as human, our intellectual and expressive experience and our quest for more.

Finally, at a time when the public forum seems increasingly incapable of sustaining meaningful discourse on the great issues of the day, our great research universities are modern sanctuaries, the sacred spaces sustaining and enhancing nuanced and honest conversation on the great and complex issues of the day. We have seen the attention span of our society decrease and the willingness of its citizens to invest in the work of thoughtfulness decline. And, in these times of high anxiety, as an appetite for simple answers, packaged in easily digestible slogans, has grown, it is necessary to assert for our great universities a potentially pivotal role within civil society both as a powerful reproach to the culture of caricatured thought and as a model of nuanced conversation. Always the best, and perhaps now the last best, venue for the full expression and development of ideas, our universities must strive zealously to live their ideal as sacred spaces where claims are tested not only by objective measures but by informed and open debate.

The attributes I have noted inhere in the general concept of the research university. Of course, in their ideal form, our research universities simultaneously deploy their agents in a powerful act of engaging students in the process of discovery and learning. The intertwining of knowledge creation and learning is intrinsic to the research university of today and constitutes for it, as we shall see, a powerful comparative advantage.

Undergraduate Education in the Research University

The very notion of the research university I offer rejects the false dichotomy—advanced frequently by enemies of the research university —between research and teaching. Moreover, the picture I paint is not simply theoretical. Those familiar with our great research universities know that, both in theory and in fact, the greatest classroom professors often are the leading thinkers in their field. Moreover, the best of our colleagues derive great joy from prompting our students to find excitement, delight and surprise in their learning. Our most distinguished faculty do not just teach; they strive to inspire our students, to light up their minds and to transmit the excitement of their fields. It is characteristic of our great research universities that we refuse to pass the precious opportunity to teach students the pleasure we live in discovery, in creativity, and in sheer curiosity. We work hard to ensure than our students do not simply seek degrees or the advancement of careers, and to stimulate them to embrace the life of the mind – while they are with us and for the decades thereafter. Thus, we embrace a dedication to teaching, even as we accept the primary burden of advancing the frontiers of knowledge.

Nonetheless, in the days ahead, if we are to maintain and nurture our great research universities, we will be forced to ask an even greater number of our distinguished faculty to be engaged with our undergraduates, to teach them and to inspire them. We must make it obvious and undeniable that the false sense of tension between research and teaching advanced by those who would undermine our great centers of learning is without foundation. Making this case will require even greater effort by those of us who care about our universities, no matter how taxed we already find ourselves.

Seen properly, the special quality of the undergraduate learning that occurs on our campuses provides an aggressive defense of the research university. As one privileged to have studied with those who were creating the next version of the subjects they taught, I gladly join the long list of those who can attest to the magic that permeates such a learning environment. Of course, the foundation blocks of that environment are faculty whose research makes a difference in their fields and in the world – and the infrastructure of support which their work requires. Only after such a foundation is well set can we begin the process of integrating students and learning. Once the foundation is set, however, we must note and nurture this integration—the explicit connection of the great researchers within our universities to students at all levels. The students who choose to study at our research universities expect to be engaged in a field, in a frame of mind, in a spirit of inquiry and in the excitement of the creative endeavor. And it is this aspect of the research university that justifies the presence of undergraduate students, and the concomitant support of the research enterprise which their tuition provides.

The case that research universities make to attract undergraduates to their doors is a powerful one: there is something inherently exciting for students about being in a classroom in which the instructor is shaping the field, an excitement which should also find itself reflected in the content of the course itself, distinguishing what is taught at a major research university and what is taught at even the best four year college. So, for example, a top professor at a college might use the same text for Economics that would be used at a research university, and she would teach it very well. But a frontier researcher at a research university, as an active player in the culture of creation, could point to where the book falls short, which issues remain unsettled, which difficulties are brushed over, and why. She could do this because she knows the subtleties first hand: her own research has helped shape the existing literature, not necessarily of this particular text, but of the body of ideas on which it rests. There is a way in which this fundamental reality is a natural corollary of the fact that knowledge is created at research universities: The college professor can know only what is in the latest journal; the university professor knows what will be in the next volume of the very same journal. If our leading research faculty engage undergraduates, the content of their courses will be different from the content of the courses offered by their former students who are teaching in colleges around the country.

My fear is that as we move through the turbulent times ahead, a disconnect could come to exist between the ideal and the reality of the research university—a disconnect which ultimately could jeopardize the very existence of the research university. One version of this disconnect might be an unhealthy separation in our universities of the research enterprise from the teaching enterprise. In my view, this version of the disconnect already is sufficiently widespread to engage our attention – manifesting itself, for example, in the tendency even at the finest research universities to entrust undergraduate teaching to part time faculty. Today, at private research universities in the United States, at least one out of every three classes is taught by part time faculty or graduate students. And this often has been accompanied by a reduced commitment to teaching for many senior faculty.

This is quite troubling, for to be attractive to students the research university must ensure the connection between research and learning which is its justification. We must take care to avoid a set of incentives which create and reinforce a dichotomy in which faculty are not encouraged to view the teaching enterprise (including the undergraduate teaching enterprise) as a natural concomitant of the research enterprise —and vice versa. We must be especially careful lest research come to be seen as the privilege, and teaching undergraduates the painful chore. Forging this special relationship with our students is an imperative, not merely because they are the university's greatest benefactors, not even because they may one day become full peers and colleagues, but because they contribute to the narrative of learning and, even while benefiting from it, can also spur insight and demand explication. Every professor has experienced the sharpening of view and the increased rigor and precision of thought that come with the task of explaining an insight to others who have not experienced the epiphany. There is an intellectual blessing in being required to answer even seemingly simple questions posed by those uninitiated in the vocabulary and models of the field. Such is the basis of the shibboleth frequently heard on the opening day of class: “During this semester, I will learn from you, as you learn from me.”

More generally and whatever the academic field, contact between senior faculty and undergraduates offers the students a vital window not only into the content, but into the teleology of a discipline. Some of these students, perhaps only a few, may become disciples in the sense of pursuing graduate or professional education and, eventually joining the professoriate. But even for those who do not, through such faculty-student interaction at the highest level, we have helped create a foundation of understanding—and hopefully, support for—the academic enterprise that our students will carry with them into their careers and lives. My experience at NYU leads me to be optimistic about the willingness of even august professors to commit themselves to undergraduate education. Some of our leading researchers, senior and junior alike, find it extremely rewarding to teach large introductory courses, ranging from economics to German history. It may seem unusual to have beginning students taught by advanced scholars, but in recent years, our best research universities have increasingly pursued this path. It is both crucial and achievable to expose students to the most advanced habits of thought and academic materials from the start of their university careers. I have found in my own Freshman Seminar that examining and reflecting on highly demanding constitutional law materials on state and religion presents a challenge that freshmen can meet in a way that stretches their minds, broadens their horizons, and lets them push themselves to a new level. To me, this is the kind of education that is possible only in a research university, where the most senior of its tenured faculty are genuinely committed to the newest of its students. It happens that students experience such encounters quite positively - in part, of course, because they are being exposed to those defining their fields, but also because people who choose to teach such seminars are naturally attracted to the enterprise of teaching and its rewards, and, frankly, are more likely to be naturally gifted teachers.

And if the research university is to maximize its value proposition, not only the faculty but also the best of graduate students will devote time to undergraduates. Doctoral students, who by definition have discovered their intellectual passion, should become ambassadors to the undergraduates both for the joys of intellectual life in general and for the delights of their chosen discipline. Particularly in these times when our undergraduate tend to overplan their lives and to channel themselves early on specific career paths, advocates for the life of the mind are important. Moreover, to the extent that doctoral students seek out

undergraduates in formal and informal settings to discuss ideas and trigger conversation, they themselves will begin to experience the rewards of the transfer of knowledge which will characterize the life they have chosen.

Creating an Ethos

I am not proposing that every tenured professor must teach undergraduates every semester. My aim is a move of the dial, a reweighing of the balance, so every student will be exposed to knowledge creators in a meaningful way – in short, will have contact not only with those who write the textbooks used in the classroom, but also with the process that is forging the ideas that will reform the next generation of those books.

If we are to urge our faculty to engage students, we must accept our obligation to outline in a clear and structured way how to best connect senior researchers to underclassmen. For example, I am certain that research universities must reexamine their curricula to distinguish those courses where the use of research faculty is appropriate and advantageous from other courses where it would be unnecessary or even counterproductive. I am convinced that education at the research university would benefit from a review, based on institutional goals, of the frequency with which many courses are offered.

Our aim overall ought to be that, even in the first year, students will enroll in more than one class with an actively engaged leader in the field, and by senior year a majority of a student's courses ought to be taught by such professors. Liberating leading faculty to do this may require reducing the number of courses offered, some of which are highly specialized, or offering such courses periodically—once very two or three years. I am confident that a rigorous course reassessment, reinforced by an enthusiasm among senior professors for undergraduate teaching, can lead to genuine interaction of undergraduate teaching with the research enterprise.

Beyond—or antecedent to—structural reviews like this is creating an ethos on campus, a way of inviting self-conscious reflection across the institution along the lines of: how should we be doing things differently because we are a research university? What is different and unique about us that should be reflected in the structure of the curriculum? Or in our approach in the classroom? Or in the academic interactions on campus? And by what measure should we be judged a success or failure?

Here is a role—a responsibility—for university leaders: to create and sustain an environment in which such an ethos of reflection is allowed and encouraged. Presidents of universities rightfully have a limited impact in guiding the flow of intellectual output on campus. Where they can be useful is in creating a habit and a process, inclusive and welcoming of all views, of review and reflection on what research universities should be doing, what goals we should be seeking, and what demands we should be placing on ourselves. In short, at any given time, we should be able to articulate our institutional mission – what might be called our *ratio studiorum*. And that institutional mission should integrate, in a way that makes a difference, our nature as a research university and the enterprise of undergraduate education for which we have taken responsibility. It is the role of the university's leaders to force this process of reflection and the conversation it requires.

Forces (Re) Shaping the Research University

The research university seen in this way – as a community of scholars and learners dedicated to a common enterprise—puts great demands on its participants. Among those demands is an awareness of our external environment and the emerging currents that swirl around higher education and place new demands on us.

Begin with the undeniable reality that powerful forces—good and bad—are reshaping our society, our times and inevitably our University. Confronting change is not a new challenge for our universities—we are, after all, merely the present manifestations of an institutional form which traces its existence back nearly 1,000 years. Universities do not simply engage in the creation, transfer and translation of knowledge as received wisdom; when they are operating well, much of what they do results in a rearrangement, a revision and even replacement of what is known. It is their role not only to develop and extend, but also to challenge received wisdom; often, it is the role of the university to disprove what we "know" as "fact." In this way, universities and change are inseparable.

Today, however, what our universities confront is not just change, but hyperchange—and most importantly, hyperchange in the very province in which they live and operate, the domain of knowledge and of ideas. Even the ways in we operate in that domain are undergoing fundamental transformation as we witness the continuing collapse of traditional boundaries—in time, in space, in disciplines and in culture. As we reflect on how we might work out way through this hyperchange environment, it is worth noting that universities are quite distinct kinds of organizations, unique in several ways. For example, we tend to buffer our cores from the demands of society, making only symbolic adaptations. This capacity explains in part our staying power; we are the carriers of tradition. Quite unlike the typical business firm, which could not buffer itself in the same way and survive the competitive rigors of the marketplace, we endure.

There are some desirable consequences of this lack of adaptation to the changing broader context. One is the role of the university as a "reservation" in the society, the keeper of the seed corn. Such buffering avoids the problem of overadaptation to what may turn out to be a passing change in the environment.

In my view, however, the hyperchange we face today compels dramatic adaptation within higher education, rooted in serious reflection on the nature of who we are, what we do and how we do it. If I am right, universities—which simultaneously serve roles as the pioneers of progress, the chroniclers of change, and the carriers of tradition—are at a critical threshold; in my view, the years ahead will see a paradigm shift in our understanding of their nature and operation.

A related but distinct challenge facing research universities arises from the irresistible force of globalization. The most familiar usage of the word "globalization" describes a transformation in the world economy. More and more, commerce and communication transcend boundaries, and transactions once merely local now routinely touch multiple continents and implicate several different legal regimes. Globalization in this sense is ubiquitous, unavoidable and undeniable—impacting for good and ill the relationships of governments, markets and the daily lives of institutions and citizens everywhere. This understanding of globalization is the simplest, the most conventional; and, it certainly is the case that, understood in this widely accepted sense, globalization is profoundly consequential and often controversial. Moreover, it is beyond dispute that the economic consequences for the modern university of interdependence and world competition will be enormous. We will be forced to adjust to marketplace competition from commercial providers, to the advent of online education, and to the explosion both of technologies and the information they deliver.

Beyond its most common meaning, globalization also refers to a deeper and even more fundamentally transformative force – embodying cultural and societal developments that touch the whole range of human experiences. Globalization does not merely require us to coordinate with those beyond our borders in ways in which we never imagined we would; it changes the nature of our borders and the structure and content of the cultures nourished and developed within them.

Globalization in this broader sense is just as much a revolutionary force as is its economic counterpart; and, it has just as much catalytic potential, both positive and negative. In the years ahead, as we encounter ourselves and others as never before, we may witness the emergence of some new homogenized ethos and culture and the death of old traditions, or we might not. Connection and mutual enrichment need not destroy diversity; they can incorporate and celebrate it. Neither synthesis nor synchronization requires sameness. The challenge is for us to find a way to channel globalization, maximizing its benefits and minimizing its costs.

But channeling globalization will not be easy. The broader conception of globalization I have offered resonates with important themes familiar to those of us who devote our lives to higher education. We know well the dangers of certitude, silence and silencing; and we are profoundly aware of the lethal nature of intellectual homogenization and party lines, whether in disciplines or in conversation. I believe that our ability to channel globalization will vary directly with our aptitude for reflection, our capacity to listen and to learn, and our willingness to be humble. We will need modesty not certitude, and we will be forced to cultivate a desire to discover new insights equal to our inclination to transmit our insights to others.

A third common challenge facing graduate and professional education is posed by technology. Technology surely will reshape our concept of the classroom. Students increasingly will be comfortable with computer-based learning and research, and less comfortable with printed material; professors who rely primarily on printed materials will appear narrow minded, and ultimately foolish. Now familiar ways of transmitting information in the classroom will become at least partially outmoded.

And, of course, by reshaping our concept of the classroom, technology also will reshape the delivery of education. In a cost conscious world—and in a world where advocates of technology based education argue that an education in cyberspace offers pedagogical advantages as well as cost advantages over our traditional "fixed facility" version—it will be impossible to stifle the development of at least some schools in cyberspace that educate some elements of the profession. These developments, like the other trends I have noted, will challenge us to justify the basic structure and form of the education we offer.

Arthur Levine, the wonderfully brilliant President of Teachers College at Columbia University, has analogized the moment at which we educators now find ourselves to the moment described by Henry Adams in criticizing his college for providing an eighteenth century education as the world was plunging toward the twentieth century. Adams believed that, in the space of only a few years at the end of his century, education had fallen 200 years behind the times. Levine, for his part, opines that economic and technological pressures are, as he puts it, "likely to force those of us who shape the academy not only to adapt our institutions, but to transform them." In this transformation, he asserts, the emphasis will be on "convenience, service, quality and affordability;" moreover, there will be "little demand for ivy," because students will "gravitate toward online instruction, with education at home or in the workplace."

Levine quotes an entrepreneur as offering him the following account of higher education: "You're in an industry which is worth hundreds of billions of dollars, and you have a reputation for low productivity, high cost, bad management, and no use of technology. You're going to be the next health care: a poorly managed nonprofit industry which is overtaken by the profit-making sector." From this, Levine concludes: "Colleges and universities are not in the campus business, but the education business." He predicts what he calls "a great convergence in knowledge-producing organizations" such as publishers, television networks, libraries, museums and universities. For him, the University of Phoenix is the harbinger of what will become the norm, with firms hiring the finest faculty from the most prestigious campuses to offer premium degree programs over the Internet.

I shudder when I read such views from one of our leading educators—and I know Arthur well enough that he himself recoils at the prospect of what he sees coming. A learning community in cyberspace is different from (and in many important ways inferior to) the learning community we have in our universities today. The depersonalization of the educational process inherent in education in cyberspace—along with the concomitant devaluation of inspiration and serendipity—is striking. Still more, the reduction of researchers and thinkers to "content people" is downright chilling. I have no doubt that the integration of technology into our teaching in a fundamentally transformative way will be necessary—and even desirable—in the more diversified educational world which is our future. The key will be using the moment of integration and transformation to accentuate the value proposition inherent in the connection of the research university and undergraduate education. This is doable—imminently doable—but it requires a consciousness of process and goal which too often is absent from the way our universities do business.

A fourth trend pressing on higher education is American society's (and possibly contemporary humankind's) deep need for immediate gratification, manifested particularly in a devaluation of long term advantages in favor of short term rewards. This general social trend will affect what we do more subtly than the other trends I have noted, but its effects will be profound. For the moment, the best external example of the deleterious impact of this phenomenon is medicine. As the economics of medical care develop, basic medical research and research hospitals are being compromised in the rush to lower short term costs. This is dangerous and short-sighted.

Of course, the devaluation of long term advances in favor of instant gratification extends aggressively to undermine the entire agenda of basic research within our universities. And, in such a world, the humanities and arts are especially fragile. We would do well to remember the words of John Maeda of MIT's Media Lab as he poignantly wrote in an article called "Scientists Look Ahead." Let me give you his views:

> Amidst all the attention given to the sciences as to how they can lead to the cure of all diseases and daily problems of mankind, I believe that the biggest breakthrough will be the realization that the arts, which are conventionally considered "useless," will be recognized as the whole reason why we ever try to live longer or live more prosperously. The arts are the science of enjoying life.

We must beware of the tendency to sacrifice the long-term gain of research for the short-term gratification of cost reduction—especially as our universities face mounting financial pressures. The cost of supporting research and research based education on our campuses increases at a breathtaking pace. The sheer volume of knowledge to be mastered and the number of fields to be represented are multiplying constantly. And, each new advancement of knowledge almost inherently entails more complexity and subtlety—and a greater marginal cost of produc-

tion. Moreover, many of the moves necessary to improve the learning experience require a reduction in the ratio of students to faculty, with the attendant increase to costs.

These increased cost pressures are pressed upon our universities just at the time that public funding for research universities—lamentably—is shrinking. Priorities such as defense, homeland security, health, Social Security, and K-12 education all are in competition—far more successfully than higher education—for societal allocation of scarce resources. To complete the perfect storm of bad economic news, our huge national debt and just as significant the growing imbalance in trade and investment between the US and other nations combine with the imminent arrival of a baby boom generation in search of its Medicare and Social Security benefits to portend even tighter days ahead.

Conclusion

These are formidable challenges at every level. In particular, each of the challenges could undermine the commitment of our research universities to undergraduate education. Still, the university as an institution has been remarkably resilient: it is worth noting that, of the 85 institutions that exist today as they did 500 years ago (entities such as the Vatican or the English Parliament), 70 of these 85 enduring entities are universities. Nothing more need be said than that to indicate the power of the core concept of the university. And, throughout its long history, the university has embraced the importance of introducing undergraduates—its first learning constituents—to the world of knowledge and knowledge creation.

Moreover, the case for the research university has never has been stronger. We are entering the knowledge century. We face a world, suddenly miniaturized by transportation, communication and technology so dramatically that previously distant peoples and cultures (and all that they do) are palpable and immediate to us.

As we, the stewards of the most spectacular manifestations of life of the mind ever created shape our universities for tomorrow, we would do well to embrace the sense that we are highly privileged in our task – and, as such, embrace fully our fiduciary roles. Some might ask, as I confess I do myself, if such a task is worth the investment of a professional life? Is it a vocational call worth answering?

Our answers are clear. Our universities answer the call by keeping faith with our history and traditions even as we build institutions to met the challenges of this new century. To me and to so many of you who have given the same answer, it is sufficient to note the fulfillment that flows from involvement in knowledge creation and transmission, which is properly regarded as a noble endeavor because it goes to the heart of what it means to be human.

Capable Language: Complex Discovery and Plain Talk

Speaker: Robert Weisbuch, President, The Woodrow Wilson National Fellowship Foundation, and President Designate, Drew University

I am in a bad position. I chose this title a year ago and now I don't have any idea what it meant. Topics are like trousers, humiliating to change in public, but I am going to—change the topic, that is. I want to talk to you about the crisis in the liberal arts and why it is all your fault, and in the midst of that I promise to re-engage the issue of undergraduate learning and research. I will even close by redeeming, or at least recycling, my original title, capable language: complex discovery and plain talk.

In talking about a liberal arts crisis, I should confess my tendency. I am aware of the habit of aging academics to imagine that the decline of civilization is concurrent with their own decline, and that both will cease utterly at the same moment. Furthermore, my mother, whose given name, bad enough, was Ferne, earned the family nickname Apocalypse Now and I have inherited her alarmist tendency. Even so, I believe we are at an authentic crisis moment, at once the worst and the best of times. How we behave in the research universities, and how we behave in particular regard to our students, will be a major determinant of whether the best or the worst prevails.

It is the worst of times because fewer than half the percentage of BAs are in the humanities as they were 40 years ago; because a whole range of liberal arts colleges have flipped to preprofessional; because the number of minority PhDs is one third the population rate and one third the number we awarded to students from other nations; because the gap between the schools and the universities, public ed and higher ed, is arguably greater in the United States than anywhere else in the world; because the dollar differences between the sciences on one hand and the humanities and arts on the other is frankly ridiculous, causing the self-defeating behaviors in the poorer disciplines that we find in the population of any poor neighborhood in a wealthy city; because two of the five largest funders of higher ed, Pew and Atlantic, have quit us, which of course harms those poorest disciplines most, quit us ultimately because they believe that self-indulgence and habit so rule in the academy that their dollar is better spent anywhere else. But mostly it is the worst of times because the expansion of high school and college degrees has been unaccompanied by any expansion of the liberal arts. The idea of "Left Behind," the idea that a real education is for the rich and narrow tech training for the rest, has now extended itself beyond the secondary schools into the universities, your universities. So given that situation I am at an immediate loss as to why I should give a damn about undergraduate research because that will not cure any of these ills.

But I am not at an ultimate loss. I actually do think our topic today offers a solution, even several solutions, to the decline I have described. But let me first say what I do not think the decline involves, and why in other ways it is a very good time. People in general have never shown a greater hunger for the topic matter of the liberal arts. The mega-bookstores are filled from dawn to midnight. The museums are packed. NPR has quadrupled its audience over the last 20 years, and the number of cultural and science-oriented cable television channels continues to increase rapidly. The world has not abandoned the liberal arts; the academic liberal arts have abandoned the world.

Let me explain that accusation. In his article "Distinctively American," on the nature and role of small liberal arts colleges in America, Eugene Lang responds to all the whining about how ignored these institutions feel by scolding them for allowing themselves to become country clubs where history and physics substitute for golf and tennis. They were begun as church-related to benefit the world, Lang reminds us, and now they have become isolated islands with the social consciousness of gnats. Again, they deserve to be ignored because they ignore to engage their students and faculty in the public uses of knowledge.

Our research universities, many of them state-based public institutions, are not liable to the same criticism. We haven't ignored the application of knowledge; we have just relegated it to that deepest circle of hell known, with a deadly nomenclature, as service learning. I recall a rhyme that kept going through my head when I was at the University of Michigan—"Core's a bore and service makes me nervous." It seemed to me that the same lack of joy that inspires distribution requirements besets the notion of service learning, where anything but rigor and

challenge was proceeding. Encouraging students to do nice things is, well, nice at best, irrelevant at worst; but it is a different and compelling matter to ask instead, of faculty and students, that they apply knowledge to confront social challenges, that they maximize the social potential of learning.

In fact, student research should involve not only deepening one's engagement with a discipline but employing the fruits of that engagement in a public arena. I don't at all discount the truth value of learning. There is something like the key intellectual moment, when we suddenly make startling sense of what had seemed random. It is, in Coleridge's words, "when a series become a whole" and Emily Dickinson proclaims, "For pattern is the mind bestowed." Hurray for hedonism, for the pure Dionysian drunken joy of discovery. I always know where to find my friend the distinguished neurologist Steven Kunkel. Before dawn and after dark, he is in his lab. He is a wonderful man, and his work is on AIDS. But it is inspired not as much by his desire to alleviate human suffering as by the thrill he gets from scientific creative discovery, and that is how it should be. We should never apologize for pushing back the darkness. Light is good in and of itself.

But Dionysius can become a silly fop when unaccompanied by a more Apollonian purpose. Learning for its own sake is not enough. We are interdependent human beings, and the most learned among us must not become the most irrelevant. Any dialogue on a serious human issue that does not include around the table an expert on history, or art, or physics, or anthropology is a disastrously incomplete conversation leading to thin-ice decisions. As David Damrosch has argued in *We Scholars* (1995), we have created a scholarly culture, especially in the humanities, of exile, where we badly need a culture of community. We need a more generous definition of the academic disciplines, where we give up our exclusivity and gain more than we lose by infiltrating every sector of society.

Let me provide a few examples from my own neighborhood, the supposedly insular humanities disciplines. The Clemente Program, initiated at Bard College, introduces poor people to the great books, and this program, now national, has had startling results. "Know thyself" really does break the cycle of poverty far more effectively than hiring someone to sling a burger or mop a floor.

Differently but again, Jeffrey Perl and his staff at the distinguished journal *Common Knowledge* have been exploring the means by which Humanities disciplines can ease international conflict, for these are the disciplines that require us to see the world through the eyes of others.

Here at the Woodrow Wilson Foundation, we have been awarding Practicum Grants in our Humanities at Work program to graduate students willing to apply their learning beyond the academy. And so a student in philosophy at Vanderbilt works in the university hospital on transplant ethics and counseling transplant patients. An historian at Stanford creates a community group of Filipinos in Stockton, the largest community of Filipinos outside of the Philippines, and keeps tens of people from being displaced by urban renewal. Another historian at the University of North Carolina at Chapel Hill opens a summer Freedom School for African American fifth-graders in Mississippi. And a cultural anthropologist at the University Texas at Austin uses autobiographical writing, dance, drawing, storytelling, everything in her discipline to help delinquent teenage girls who had been abused as children to improve their self-images.

I take these examples from the Humanities because, as in Sinatra's New York, if we can make it there, we'll make it anywhere, the "it" in this case public scholarship.

To return to the systole/diastole of the arts and sciences heartbeat, both the pleasure principle and the responsibility of the intellectual, I want to argue that we provide each of our students with a means to go far, far out on a mental limb and then far, far out into the world of urgent challenges. So that leads to two of the major issues we are asking at Woodrow Wilson in our doctoral initiative, The Responsive PhD, how we make scholarship and learning more adventurous and how we apply our learning to the world. Or is that a single concern? In any case, I see no reason why we cannot transport exactly those emphases into the undergraduate realm.

The first question is to ask simply, what encourages and what impedes adventurous learning? This includes that practice universally praised and just as universally under-funded, the multidisciplinary. When I was chair of a very large English departments, the programs, with no independent budget, thought of me as Moby Dick. But I thought of myself as a leaking Pequod, for I kept losing my most interesting faculty to programs like Women's Studies and the Medieval and Renaissance Collegium. I didn't just lose them; the freshmen and sophomores did also. We seem to think sequentially—the disciplines for beginners, the multidisciplinary for sophisticated adepts. Why do we keep our best habits of thought for later? I applaud the Harvard effort now ongoing to replace a core curriculum with freshman courses based on big questions that involve several disciplines at once. Meanwhile, interdisciplinarity is a budget item, not something you can cheat on. You may have to make tough, explicit choices, but as Johnny Cochrane might say, if it doesn't cost it, must get lost.

But even beyond the question of the interdisciplinary, we could use some benchmarks for when learning gets exciting and then import those sites of excitement into every offering. This requires a kind of close daily assessment well beyond the usual course evaluation. And then, when we discover our failures, I will repeat my old dictum—if the faculty does not want to teach it and the students do not want to take it, don't offer it; you must find a new way.

In the undergraduate curriculum, we can translate adventurous scholarship into adventurous learning. Too often in our large universities, the most interesting cognitive supplies rest on the highest shelves, out of the reach and even the sight of freshmen and sophomores. Why save interdisciplinarity for afterwards? And why give the most inexperienced or indistinguished instructors to the most inexperienced students? And why create 75 different majors at even small colleges without spending a minute in worrying about their coherence?

My extremely, almost ridiculously distinguished colleagues on this panel will have much more to say about student learning; and cognitive science will have still more to say if it will make common cause with the disciplines. If we can pair cognitive scientists and their laws of learning with real-life historians and physicists and their laws of the tribes, we can revolutionize learning in our lifetime. That last phrase is for my mom, Apocalypse Ferne.

I've already spoken to the second question in our Responsive PhD project, how we apply academic learning to social challenges, and how, more largely, we create a permanent dialogue between the mentors of students and the employers of students.

Before I get concrete about how this can relate to the undergraduate experience, I urge two redefinitions in this regard. First, I would ask that when we engage with our undergraduates in research, the mission include not only learning but application, application with the same rigor as the learning. Students require an immersion. Indeed, a good education provides them with a sense of wonderworlds, of understanding

that though the street may look barren, they can lift one manhole cover and find a world of gemology, another to find a whole world of baseball lore, another to uncover a world of lyric poetry, another to display a world of physical laws or mathematical logic or architecture. A liberal arts education provides a sense of the unending interest of the world and a means for lifting those covers. In the course of such lifting, they learn something about themselves and engage a quest for self-knowledge. They learn something about how to squeeze themselves into the minds of other people, alien and even opposed to them, a saving grace in a 9-11 world. They learn, as the cliché goes, about how to learn. Each particular dive into a wonderworld finally goes toward a capacity to swim in the general ocean of inquiry.

But students also need to come out of the water and onto a mainland shore that requires their expertise. That means working on all sides of the equation, on engaging faculty first in a more generous notion of their disciplines and in making a keener distinction between acknowledging some occasional requirement of a thinker to be protected from social noise and pretending that irrelevance is a virtue.

A second redefinition concerns that soggy word, service, the third and last typical grounds for faculty evaluation and promotion. Service now too often means membership on overpopulated college committees that meet too late in the day for too long to do anyone any good. At Michigan, I asked my colleagues to teach more freshman courses. In exchange, I cut the number of committees by one-third and the membership of each by half. This was the single best act of my poor career.

Service should mean something far different, that is, how each faculty member is employing her learning to serve the social good. A typical medieval historian will balk at that requirement; but ask her to think with her best mind for ten minutes on the possibilities and well within the first five she will suddenly say, "well, I always wanted to…" and the sentence will get completed with a surprising and compelling idea, anything from creating a museum exhibit to organizing a festival to introducing the subject to eighth graders to whatever.

But these are faculty issues, not student ones—or are they? Students imitate the habits of faculty they admire. If we want to create an engaged student cohort, we might begin by reforming our own scared and sheltered selves. We can come out of hiding and still get our work done. In fact, our work will be improved. I mentioned earlier some examples of our Practicum Grant awardees who spent a summer practicing their discipline in beyond-academic settings. We now have over 100 such examples, and have begun an assessment. I can tell you already that those awardees get the doctorate far more quickly than their peers because, I think, they are no longer afraid of what comes after. They also graduate to excellent positions within academia or beyond. They have learned that their knowledge matters and the world becomes their oyster.

One of the great things about Eugene Lang, one of about five hundred, is that he doesn't just talk but he acts. Gene has created the Pericles Project, engaging roughly fifteen small colleges in challenging their students and faculty to bring it to the street, to employ their knowledge toward community initiatives. Gene is excluding research universities at this point because he believes, not without reason, that public universities in particular are prone to too many political pressures to make this work. Prove him wrong.

Now to my godforsaken title, left out in the cold night shaking and naked like Poor Tom. Capable Language means something like learning that can do something, including explain itself to other people not wholly versed in the technical language of each specialized field. It is language that capably, effectively communicates, but it is also language that leaves the pastoral realm of texts to enact knowledge, to be capable, in the city of events. By the phrase "complex discovery" I intend that excitement with difficult intellectual materials that gets all of us scholars out of bed in the morning, that initiates our forever-young student-ness in acts of arrested attention. But it is complex because it is bi-directional, not only the mind enforcing itself upon experience, but experience tutoring and correcting thought. And the last term of my endangered title, plain talk, is what I hope I have provided today, a translation of difficult materials into the kind of speech that can lead to action when the language, never an end in itself, ends.

Resources/References

Websites

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2. The Responsive PhD at The Woodrow Wilson National Fellowship Foundation Foundation http://www.woodrow.org/responsivephd/
3. Pericles Project: www.projectpericles.org
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How to Engage the Full Range of Students on the Proper Range of Topics in the Best Way . . .

Speaker: Howard Gardner, John H. and Elisabeth A. Hobbs Professor of Cognition and Education, Graduate School of Education, Harvard University

Note: Howard Gardner spoke informally at the Conference and his tape-recorded remarks here have been edited only in the interest of clarity.

Our universities are now serving a population that is more diverse than ever before, raising serious questions about how best to engage the full range of this diverse population. The answer to these questions is compounded both by the exponential increase in knowledge during the last half of the 20th century, and by the rapid increase in access to this knowledge brought about by technological advances. How do we decide on what to focus and how do we ensure that we reach students as effectively as possible? In responding to these questions, I will look to two areas of psychology for clues: 1) Insights from cognitive psychology on the nature of understanding and how best to assess it; and 2) Insights from differential psychology on the nature of different human intelligences. Some of what I say will be drawn from two of my recent books, *The Disciplined Mind* (2000) and *Intelligence Reframed* (2000), as well as the substance of my work on The GoodWork® Project (http://www.pz.harvard.edu/Research/GoodWork.htm).

First, let us examine the climate of current educational challenges that research universities face. There are both external pressures and internal psychological constraints that make our tasks as educators difficult.

The external pressures include increasing careerism, the marketization of just about everything in higher education, including the marketing of professors, and a concurrent (and perhaps related) decrease in intellectual curiosity on the part of students. Ironically, these changes are taking place amid an explosion of knowledge (and pseudo-knowledge) and technology which opens up all kinds of possibilities. Collectively, these pressures have created an academic environment in which students need to learn to separate intellectual "wheat" from ambient "chaff."

A major psychological constraint on effective education is the difficulty of responding to the different kinds of minds or "intelligences" represented within and across demographic groups and among disciplines at a university. Figure One outlines some of these differences, designating kinds of individuals who stand out in terms of one or another intelligences. Note that all individuals possess all of these intelligences, but that we differ from one another in our profiles of strength and weakness.

Figure One

Linguistic	*poet*
Logical-mathematical	*scientist*
Musical	*composer*
Spatial	*architect*
Bodily-kinesthetic	*dancer*
Interpersonal	*leader*
Intrapersonal	*reflective individual*
Naturalist	*botanist*

Educators face numerous obstacles in fostering the development of these different forms of thinking. Two obstacles that stand out are the very real, unexpected difficulties of achieving truly disciplinary understanding, given students' limited exposure to genuine disciplinary thinking (as opposed to mere recitation of factual information), and the difficulty of working with and training the "unschooled mind" so that it moves toward understanding.

Figure Two

The Unschooled Mind	
Science	*Misconceptions*
Mathematics	*Rigidly Applied Algorithms*
Social Studies/ Humanities/Arts	*Scripts and Stereotypes*

It should be emphasized that "understanding" is itself a performance that is very difficult for students to achieve. The disciplines, with their unique intelligence and modes of thinking, are key arenas for their acquiring it. Schooling the disciplinary mind for example, will enable the budding scientist to learn to disregard misconceptions, the novice social scientist to ignore preconceived stereotypes, and the mathematical student to transcend the rigid application of algorithms.

The way higher education is currently structured, numerous obstacles impede students' development of understanding. Some of the most prevalent are the common use of multiple choice and short answer tests, which encourage and measure memorization and rote learning of information, but do not reveal understanding (or misunderstanding) of the concepts underlying the information; text-based tests which ask students to repeat content, without requiring that they reflect on it and apply it appropriately in new situations; correct answer compromises made for reasons of efficacy; and the pressure on instructors to cover a large number of topics, far more than students are able to process, retain, and use productively.

The New Imperative

The new imperative for educators is to nurture five minds for the future: The Disciplined Mind, the Synthesizing Mind, the Creating Mind, the Respectful Mind, and the Ethical Mind. This nurturing will require establishing and keeping clear "uncluttered" goals. These goals are needed at traditional four year colleges as well as major research universities.

The Disciplined Mind

The Disciplined Mind considers the ways of thinking in major disciplines —in science, history, mathematics and the arts, as described by Professor Donald in her talk yesterday. The scientist, for example, knows that correlation is not the same as causation and considers matters of evidence rather than faith and opinions. The historian is concerned with the role of the human agency and avoids "presentism." Unlike in science, each historical event is unique and cannot be replicated. Each generation needs to rewrite history in terms of its own concerns and in reaction to previous historical efforts. Mathematicians think beyond mere formulas; they understand the nature of proof and discovery. Artists likewise master skills and media so that they can ultimately transcend popular forms or imitation of earlier models.

How can we use our multiple intelligences to help students understand complex disciplinary concepts? There are multiple entry points through which they can develop key concepts:

- Quantitative/logical learning
- Narrative
- Existential
- Aesthetic
- "Hands-on" experiences, and
- Interpersonal and collaborative activities

The Synthesizing Mind

The Synthesizing Mind, exemplified by Charles Darwin, is a mind that can take large amounts of undigested and unevaluated information, similar for example, to information that may be found on the Web, integrate it and produce a synthesis that takes knowledge and understanding to the next level. This mind is likely to become ever more important in an age where there is too much information about and individuals must decide on what to focus and how to arrange the information in ways that are useful to one self and to others. It is amazing how little my discipline of Psychology has yet determined about the act of synthesis.

The Creating Mind

The Creating Mind, epitomized by Albert Einstein and Virginia Woolf, is robust and even iconoclastic. A master of one or more disciplines, this mind synthesizes what is known and, going beyond that, thinks outside the box—an imperative in the computer (algorithmic) age. It asks good questions and new questions. The Creating Mind is ultimately judged in terms of its effects on future work and understanding in relevant domains.

The Respectful Mind

The Respectful Mind goes beyond mere tolerance and accepts and celebrates diversity as a fact of life at home and abroad. This mind has a need to understand the perspectives and motivations of others. In achieving this understanding, it is guided by emotional and interpersonal intelligence. The Respectful Mind will not be nurtured in students unless it is also exhibited by parents, teachers and administrators—and, it is necessary to add, by politicians, entertainers, and other public figures.

The Ethical Mind

The Ethical Mind is geared toward "good work," which is work that is excellent, expert, and socially and morally responsible. It is work that is intrinsically motivated, rather than work done chiefly to satisfy someone else's rewards or punishments. Teachers and researchers, as professionals, have an imperative to be themselves models of good work since students have a real need to be exposed to such exemplars. Students also need to be cautioned about and learn to recognize bad or compromised work. Ultimately a society's fate is determined by the quality of the work done by its professionals and other practitioners.

As Ralph Waldo Emerson taught us, Character (which includes self-knowledge) is more important than Intellect. While the first three types of mind foster intellectual understanding, the Respectful and Ethical Minds emphasize the development of positive personal and social values.

Speculations About How to Nurture These Five Minds in Four Years

The educator's imperative is to create an ambience in which these minds are modeled and embodied. We need to be innovative in the way we offer courses and experiences in at least the major disciplines, with appropriate performances of understanding, and we should be wary of offering interdisciplinary courses unless students have mastered the constituent disciplines.

Next, we should give students the opportunity to go beyond disciplinary competence in at least one subject so that they can have experiences of synthesizing and perhaps creating—though often it is easier to thwart than promote creativity. Further, respect and ethics cannot be postponed, but should be modeled and infused in students' course work and other experiences throughout the four years. The undergraduate years are perhaps the last opportunity students have to develop these qualities before entering "the (all to rarely respectful and ethical) real world."

Resources/References

Websites

For those who would like to read more about my proposals and models the following Web sites are recommended:

1. goodworkproject.org
2. pzweb.harvard.edu
3. howardgardner.com

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POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Gardner/Powerpoint.pdf

Breakout Session: Taking it to the Streets: Integrating Public Scholarship and Undergraduate Research

Leaders: Julie Ellison, Professor of American Culture, English, and Art and Design and Founding Director of Imagining America: Artists and Scholars in Pubic Life, University of Michigan; and Dennis Jacobs, Professor of Chemistry, Faculty Fellow of the Center for Social Concerns, and Vice President and Associate Provost, University of Notre Dame
Recorder: Timothy K. Eatman, Project Director and Research Associate, Imagining America, University of Michigan

Summary

Twenty-five attendees from a variety of institutions and departments participated in this session. A survey of their reasons for choosing the session revealed three main interests:

- We are starting a project or initiative on our campus and would like to learn more about what others are doing. What works and what does not work in the realm of community-based research?
- We are seeking the most effective ways to develop horizontal connections/collaborations on campus.
- We need synthesis strategies to facilitate the integration of civic engagement into undergraduate research. What are the some of the strategies that campuses have employed that have proved effective?

These interests were congruent with the goals of the session, which were to develop strategies to connect the student engagement agenda to the public engagement agenda and to address the challenges of incorporating community-based research into undergraduate programs. The session leaders presented two compelling initiatives, one in the physical sciences and the other in the domain of the arts and humanities. In describing these initiatives, the presenters were careful to note structural issues and logistical particulars, as well as lessons learned, and to point to common elements of many best practices. In addition, the session leaders described the evolution of their own interests in community-based research and the value they feel it brings to undergraduate education.

Presentations

Jacobs: "Community-Based Research in the Science Curriculum"

The inspiration and intellectual springboard for this initiative was a short phrase in the University of Notre Dame's mission statement that caught session leader Jacob's attention and led him to reflect on his role at the university:

> "The University seeks to cultivate in its students not only an appreciation for the great achievements of human beings but also a disciplined sensibility to the poverty, injustice and oppression that burden the lives of so many. The aim is to create a sense of human solidarity and concern for the common good that will bear fruit as learning becomes service to justice." (underline added)

As a faculty member and research scientist engaging a mostly traditional research agenda, Professor Jacobs was challenged by the tenet of "learning becoming service to justice" and began to consider

how it might relate to his own teaching. An opportunity to respond to the challenge came with an invitation he received from the Notre Dame Center for Social Concerns to re-think his undergraduate Chemistry curriculum to emphasize the connections between the study of science and the needs and interests of society. Working with three undergraduates, he came up with an idea: To have his students apply concepts and techniques they learn in chemistry class to the critical issue of reducing lead poisoning in South Bend. This nascent idea eventually led to the development of CHEM 331: "Chemistry in Service of the Community," an undergraduate course that provides "a meaningful community-based learning experience for students interested in applying chemistry to directly serve the needs of the community. Students join with community partners in helping to identify neighborhood homes that have unsafe levels of lead contamination." (http://www.nd.edu/~djacobs/chem331.html) Since lead poisoning disproportionately affects low income and minority children ages one through five living in houses built before 1946, the effort to rid the houses of lead has important social, economic, and policy dimensions. (Data from the Center for Disease Control report, for example, show that while about 6% of children overall have some levels of lead poisoning, the proportion among low income and minority children is as high as 22% in some cases.) Thus from the outset CHEM 331 was conceived of as a multidisciplinary course with socio-economic as well as physical science content.

A documentary style video was presented to show the project in action. In it, Professor Jacobs, his students, a community collaborator called Greentree Environmental and environmental professionals are assessing a local house for lead poisoning by drawing maps, taking soil samples to use in an analytical course and engaging residents in a professional manner. The assessments includes a close examination of high friction areas in the homes where paint dust may become airborne, as well as water run off areas around the perimeter of the home. The samples the group collected, viewers are informed, will later be examined by the students and by a professional laboratory.

The course, with its strong community component, fosters student learning in several diverse arenas: Among them are

- Professional Expertise: Applying chemical principles and expertise to solve problems
- Social Concerns: Understanding the needs and concerns of members/groups of our society and identifying root causes of societal problems
- Leadership: Recognizing, nurturing and harnessing the gifts that individuals bring to a team
- Civic Engagement: Making commitments toward bettering the world through action, including affecting institutional change

In addition, the students are compelled to think about legal issues since a high percentage of families in the affected communities rent rather than own their homes, and the tension between tenants and landlords over residential improvements often leads to legal battles.

This learning could not be achieved as effectively, if at all, in a typical chemistry classroom setting. Further, it complements and strengthens students' understanding of principles and techniques in chemistry research studied in the classroom and it hones their research skills. Anecdotal stories and comments by the students make clear the extent to which the project adds value to both their overall learning and maturity and their knowledge of chemistry.

Session leader Jacobs pointed to several challenges that must be addressed in developing and implementing a course like CHE 331 which integrates classroom study with community-based research. They include:

- Developing genuine community partnerships
- Identifying key questions to study
- Inviting meaningful community participation
- Embedding community work like this within the existing curriculum and academic culture
- Gaining recognition within disciplines and the academic community generally of the value of community-based research and its potential to bring about social change. Papers on projects like Professor Jacob's do not fit the standard publication model in academia
- Scaling up: How to involve more faculty, students, and community partners over time?
- Finding ways to support students so that they can continue their work after the semester ends
- Addressing the absence of project-based teaching and research in the professional practice of the humanities

One crucial aspect of a program's health is its resource network. At Notre Dame this project enjoys the support of several key units:

- The Center for Social Concerns
- The Ganey Community-Based Research (CBR) Award which provides $5,000 annually toward the project
- The Ganey Collaborative Community-Based Research Mini-Grants ($5,000 each)
- The Faculty Fellows Program
- Course Development Grants of $2,500 each
- A booklet published by the Community-Based Learning and CBR every semester which includes course descriptions

It is important to note that while the formal course content provided a critical introduction to concepts and techniques the students would require to carry out the project, the students continued the work outside the bounds of the semester, testing parks and becoming involved with other issues involving health and city planning. A group of students is currently working with the public housing authority on mold-related issues.

While the course has enjoyed some success, the long-range goal is to institutionalize it and others similar courses with a community component into "the life" of the university so that they are considered normal course offerings. This is no simple matter. Negotiating the community dynamics that come into play with this kind of community-based research inevitably presents challenges. In this case, one major challenge was to understand the local culture and norms and gain the confidence and support of local residents so that they would welcome the students and give them access to their homes. At the same time, community-based projects represent rich opportunities to build relationships between the "town" and the "gown," to enhance student/professor relationships and ultimately to give genuine meaning and value to the University's mission statement.

Ellison: Imagining America: Artists and Scholars in Public Life

Using "locks and keys" as a metaphor, session leader Ellison began her presentation with reflections on her entree to work in the area of public scholarship. It occurred after she assumed a challenging position in the central administration at the University of Michigan: "After much experience and three books I was now positioned in the realm where I had to be a university representative—a face." Not unlike a ferry operator "in the zone" between two banks, she sought "a shared language to move in a different domain of practice." One subject that intrigued her was the role of the humanities and arts in public scholarship. Noting the striking lack of a tradition of project-based teaching and learning in the cul-

tural disciplines, she asked: "Where do the Humanists and Arts factor into public scholarship?"

Her first step was to survey her own institution, the University of Michigan, where she found several scattered, but interesting initiatives and lots of good energy. It became important to put folks in touch with one another, as well as with museums, libraries, K-12 school, churches, and other local organizations and, with them, to identify opportunities for civic engagement and public scholarship: If we can be creative, opportunities abound for developing publicly-engaged knowledge and articulating a clear agenda for academe. Equally important was to develop understanding of two key questions: What are the identities of public scholarship? Who are the natural and likely community partners? Professor Ellison's vision of the special opportunity for the arts and humanities to engage issues of relevance to the community led to the founding of Imagining America: Artists and Scholars in Public Life, a consortium made up of institutions of higher education and dedicated to involving the arts and humanities in civic engagement.

Imagining America's experience suggests that there are four key areas for engagement in the arts and humanities:

- Institutional change through the Office of the Vice President for Research, with the VP becoming an advocate both for the arts and humanities and for public scholarship
- Higher education change through Imagining America
- Pedagogical change through project-based public scholarship courses
- Cultural sector change through alliances with non-academic networks and associations, such as the International Coalition of Historic Sites of Conscience, the Association of Performing Arts Presenters, the Federation of State Humanities Councils, and the Americans for the Arts.

Imagining America's mission is "to strengthen the public role and democratic purposes of the humanities, arts, and design. In order to fulfill this mission, it supports publicly-engaged academic work in the cultural disciplines and the structural changes in higher education that such work requires. Its major task is to constitute public scholarship as an important and legitimate enterprise. Its activities are based on the conviction that making universities more civic requires ongoing collaboration with partners in the public and non-profit arenas. Imagining America's programs focus on building a national community of public scholars, researching the scope and practices of public scholarship, creating models of program infrastructure, making new work visible and audible, establishing platforms for civic conversation, carrying out strategic educational and scholarly initiatives, and forging regional alliances." (http://www.ia.umich.edu/default.asp)

Professor Ellison continued the "locks and keys" metaphor to note some of the "keys" that can be used to open the "locks" and address barriers to public scholarship:

Lock: The gulf between research support systems and public engagement support systems on campus

Key: Vice Presidents for Research become patrons of public scholarship

Lock: As the American public become more racially and ethnically diverse, pressures for institutional engagement are rising, even as campuses and foundations retreat from race-based affirmative action policies

Key: Sustain affirmative action in universities and foundations; make intercultural learning central to student and faculty engagement

Lock: Faculty promote community-based undergraduate research without being able to claim their own public scholarship as 'real research'

Key: Establish a national 'tenure team' initiative to develop strategies for valuing public scholarship in the cultural disciplines

Lock: Few publication outlets exist for public scholarship in the cultural disciplines

Key: Start a 'new public scholarship' book series with a university press

Lock: Research universities listen to one another, but learn little from other kinds of institutions that are more nimble, less devolved, or more experimental when it comes to public scholarship and community-based teaching and learning.

Key: Find the places where different kinds of institutions are learning from one another

Imagining America began in 1999 as a two-year program of the White House Millennium Council, the University of Michigan, the Woodrow Wilson National Fellowship Foundation, and twenty college and university presidents who formed a partnership to support this enterprise. Two years later it became a national consortium of colleges and universities. Its current membership of 60 institutions covers a broad spectrum of American higher education: Community colleges, liberal arts colleges, arts institutions, comprehensive institutions, and public and private research universities.

While the comprehensive work of Imagining America touches a myriad of faculty and students throughout the consortium, Professor Ellison also connects this work to her own teaching. Recently, with her students, she developed a self-evaluation tool for her undergraduate course American Culture 498: "New Humanities Competencies for Public Scholars." This assessment tool helps the students to reflect on the evolution of their ideology and competencies relevant to civic engagement and community-based research, as may be seen in the following sample items:

- Ability to reflect on questions of what democracy, citizenship, and 'publicness' mean for my work. If I plan to be a teacher, a media worker, a librarian, a staff member at a cultural nonprofit, a scholar, a performer, how is my work 'about democracy' or 'about citizenship?'
- Speaking ability needed to build relationships, advance projects, develop alliances, engage in public programs, and persuade collaborators and institutional patrons.
- Ability to write accessible prose in several genres: In addition to essays, these include proposals and research reports. Also the ability to write collaboratively and to write under the 'real world' or 'just in time' conditions of project-based work.

There is a great need to develop these kinds of tools that both help measure the impact of community-based research experiences from the student perspective and set students expectations for the interrelationships between academe and life.

Discussion

A question was raised about the efficacy of translating existing courses versus creating new ones in developing curricula with a community focus. Professor Jacobs recommended a hybrid model, configuring existing courses with an add-on option consisting of enriching experiences that complement the classroom curriculum. Students who take the extra option—the community-based research portion of the course-meet one evening each week outside of the regular class time and receive additional credit. In the case of CHEM 331, he is able to bring

the community-based project directly into the class by having the students analyze samples collected on site instead of analyzing the commercially purchased samples that are typically used in chemistry classes. In academe it is prudent to employ an amelioration model that seeks to discover ways to join with something that is already there. This is especially important when considering the university's role in addressing a culture of charity and a variety of community focused issues.

Professor Ellison asserted the principle of "knowledge co-creation" which requires researchers in a community-based context to develop a mindset of expectation that "we will receive as much as we give" in these efforts. This paradigm is antithetical to the "savior" ideology that is so easily associated with community-based research or assessment work as conducted in academe. The Office of Professional Development and Public Engagement at the University of Texas Austin is an excellent example of an administrative unit that has this knowledge and understanding of co-creation, with a range of creative projects that demonstrate community engagement as well as intellectual entrepreneurship.

Increasingly, full-time faculty member are being replaced with part-time adjunct faculty who tend to have greater teaching loads than their full-time counterparts and minimal research involvement. This trend is a response to the perennial challenges around decisions about sustaining and investing in programs. Resources are always an issue. How do we do more with less? This can be answered in part by the hybrid model proposed by Professor Jacobs, but at an institutional or structural level the challenges beg great depth and are at the core of the institution's philosophy. As both of the projects that were presented demonstrate, much positive energy emanates from faculty members who take the mission of the university seriously and dare to engage in the level of professional reflection and collaborative spirit that can lead to ameliorative efforts as the proper focus is brought to bear.

The multidisciplinary nature of community-based research raises serious issues that must be considered. They range from overcoming distrust, to managing expectations, to managing partnerships to sustainability. Because of their complexity, they require multilateral engagement by a variety of campus units. Equally important, there are several important questions that must be addressed: What are the genres of public scholarship? What are the most useful and meaningful ways to evaluate this work? How do we make room for fresh intellectual perspectives and models without mitigating the myriad of useful traditional approaches to research and teaching? Sustainability is also a key issue because at the end of the day if public scholarship cannot be sustained and we move backward, the situation will be worse than when we began.

Finally, community-based research faces the persistent challenge of funding. Funding should be for specific projects, not just faculty. We must find ways to award faculty for engagement that transcend the principles of grantsmanship. Many institutions are taking a closer look at funding projects that are put forward by a team that includes members of the community. The deepest principles of community engagement are violated when securing resources is diminished to "history for hire." Ethical issues are paramount especially when working with funding agencies.

Recommendations

For Individual Campuses

Through its own work the Imagining America consortium has found that many faculty are involved in high quality community-based research or in research projects with this potential, but they do not promote them because of the threat of disparagement about "soft" research or projects that suffer from gross underexposure. Addressing this pervasive dynamic will require a critical analysis of the rewards system and the development of sound rubrics for the evaluation of non-traditional research. Community-based units on campus like the Center for Public Engagement at Duke University should extend personal invitations to faculty for informal interaction, with the aim to stimulate community-based notions into teaching and research.

Three recommendations were put forward to increase faculty engagement in these kinds of endeavors.

- Faculty and administrators should work together to create mechanisms on their own campuses for bring bringing faculty together to focus on these kinds of projects. The AACU and other professional associations provide these kinds of opportunities for a wider group.
- Faculty and administrators should work together to develop community-organizing skills among faculty on their campus. One strategy is to bring in leaders in this area. Two luminaries they might want to invite are Harry Boyte, author of *Everyday Politics* and a member of the Council on Public Engagement (COPE) at the University of Minnesota, and Maria Avia who spent a year having one-on-one conversations with faculty members.
- Campuses individually and collaboratively should disseminate best practices and effective models of public scholarships so that individuals can understand and translate them on their campuses. Two good models may be found at the University of Wisconsin-Milwaukee and the, University of Massachusetts Arts and Citizenship program.

For The Reinvention Center

The discussion generated several "big ideas" that The Reinvention Center may find useful for future directions:

- The Reinvention Center should consider making the issue of public scholarship and institutional change the major focus of a conference or regional meeting emphasizing the social context of knowledge. One specific focus might include the importance of democracy and a critique of injustice as it relates to academe.
- Collaborative work is needed in the area of defining the various genres of public scholarship. The Reinvention Center should foster discussions that will contribute to the development of such definitions through its regional network meetings, list serv, Spotlight and other mechanisms
- It is imperative that entities like the Reinvention Center continue to find ways to encourage change in relation to the value and rewards system generally and for faculty in particular.
- Engaging faculty in community-based research requires quality, face-to-face interaction. This may be best viewed as building human capital. Targeting faculty through disciplinary associations and other scholarly networks may yield the best results.
- It is important to promote project follow-up as a critical aspect of community-based research. To maximize the quality of the research experiences critical questions must be addressed. For example, what happens when students come back into the classroom? What constitutes good/valuable reflection? These are worthwhile questions to raise at regional network meetings.
- Corporate and media elements should be brought into the discussion at Reinvention Center conferences to "spread the word" and to capture useful external perspectives.

Resources/References

Websites

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3. Council on Public Engagement (COPE): http://www1.umn.edu/civic/

Publication

Boyte, Henry (2004). *Everyday Politics: Reconnecting Citizens and Public Life*. Philadelphia: University of Pennsylvania Press

Breakout Session: Developing Resources and Funds to Support a Research-Based Undergraduate Education

Leader: Patricia Iannuzzi, Associate University Librarian and Director, Doe/Moffitt Libraries, and Interim Director, Collections, University of California, Berkeley and Designate Dean of Libraries, University of Nevada, Las Vegas
Recorder: Mark Feldman, Campuswide Consultant, Graduate Student Instructor Teaching & Resource Center, and PhD Candidate, Rhetoric Department, University of California, Berkeley

Presentation

This session focused on how to develop and leverage the varied resources needed to support research-based undergraduate education. While many of the other conference sessions explored the educational and cognitive benefits of teaching research or focused on how to best teach research in a given discipline, this session, in a sense, began where those left off. This session assumed that research-based education is valuable and explored how best to deliver research-based education to larger numbers of students and to institutionalize research-based learning. Barriers to wider-scale adoption of research-based learning and some possible solutions were also discussed.

Although some funding is available to implement research-based learning initiatives – either through private or public foundations or internal university monies – the more vexing challenge is how to ensure that such short terms changes become systemic and penetrate the university's institutional culture. Session leader Iannuzzi shared the University of California, Berkeley's experience with a four-year collaborative project, funded by the Mellon Foundation, that aims to incorporate research-based learning into undergraduate courses. The project, in its second full year, continues a two-year pilot project, relying on collaboration across academic and non-academic units and across administrative levels. This year the project is targeting large-enrollment courses. Iannuzzi also shared experiences and insights on how to raise funds to support undergraduate research through the university library's programs and spaces.

Participants discussed the following subjects:

- Individual and institutional experiences in integrating research based-learning into the undergraduate curriculum and in cultivating funding sources.
- How to build individual and institutional and commitment to undergraduate research-based education.

Questioning Our Assumptions About Research-Based Education

At the beginning of the session participants filled out a brief worksheet that asked them to agree or disagree with a series of propositions about research-based undergraduate learning. Some sample items:

Research-based learning:

- Requires students to formulate their own question(s)
- Entails covering less material in the course
- Results in a research paper or presentation
- Is more time consuming for the instructor

After completing the worksheet participants shared their responses with their neighbor, noting points of disagreement. The entire group then discussed these statements.

In this exercise participants affirmed that research-based learning can be highly varied and need not fit conventional models of laboratory or library research. Rather, it can include only one or several components of the research process, can be directed by the instructor to various degrees, and need not culminate in a research paper. Having a broad definition of research-based learning is essential to incorporating research-based learning effectively in large enrollment course; delivering research experiences to larger numbers of students; and reaching more typical as opposed to high-achieving students.

The Parable of the Mellon Seeds

Session leader Iannuzzi gave a detailed account of UC Berkeley's experiences obtaining funding from the Mellon Foundation and implementing the grant, "Library/Faculty Fellows for Undergraduate Research." More information regarding all aspects of this project can be found at: http://library.berkeley.edu/MellonInstitute/.

In 2001 Don Waters, a Mellon Foundation program officer, met with five newly-appointed directors of research libraries, including UC Berkeley. The Mellon Foundation was interested in how librarians, technologists, faculty, and students can work together to ensure that needed knowledge management skills are gained and disseminated. In addition, the Mellon Foundation was interested in innovative models for how universities can invest and assist faculty and academic support staff in developing and teaching research skills.

The UC Berkeley Library saw the Mellon initiative as an opportunity to reach out to campus partners and share what has traditionally been seen as the province of the library. The Library partnered with the Vice Provost for Undergraduate Education (Christina Maslach), and submitted a grant proposal, "Library/Faculty Fellows for Undergraduate Research." The Mellon Foundation awarded UC Berkeley, first, a two-year grant of $138,000 for a pilot project, and then a four-year grant for $750,000.

The project's objectives were to:

a) Build undergraduate knowledge of information resources
b) Enhance student research and information competencies
c) Connect faculty research more effectively with classroom teaching
d) Provide expanded opportunities for faculty to mentor creative student discovery and research both within and beyond the classroom

Additional concerns were to ensure that this educational initiative be both scalable and sustainable, beyond the duration of this particular grant.

Each year fifteen Library/Faculty Fellows for Undergraduate Research are selected from a larger pool of applicants. The Fellows are faculty and lecturers who are interested in redesigning an undergraduate course to include research-based learning. The project aims to develop

and nurture a cohort of faculty dedicated to a new way of teaching, who can effect change within their departments and throughout the University. The Fellows are envisioned as agents of change who will actively share their experiences with undergraduate research-based learning. Each year a different cohort is targeted; this year the project has focused on large-enrollment courses.

Faculty Fellows participate in a three-week Summer Institute. This is an experiential, immersion experience in which the Faculty Fellows become students. As students, they are asked to empathize with the challenges students face and to bring that knowledge back into the classroom in their role as teachers. Fellows, for instance, gain insight into how difficult and daunting research can be outside of one's areas of expertise. During the institute, each Fellow redesigns a course syllabus to incorporate undergraduate research assignments that use the Library's print and digital collections.

The Institute curriculum was designed by staff experts from academic support units campus-wide, including the Library, the Office of Educational Development, Educational Technology Services, and the Graduate Student Instructor (GSI) Teaching & Resource Center.

Participating Fellows commit to teach their course in the following academic year. Each Fellow is supported by an implementation team (I-team), made up of staff from the academic partners who work together to support the course. Academic partners include: the Division of Undergraduate Education, Educational Technology Services, GSI Teaching & Resource Center, Office of Educational Development, and the University Library. More information is available at: http://library.berkeley.edu/MellonInstitute/Mellon_Partners.htm.

An evaluation consultant was hired to work with the project partners on an overall evaluation plan, and an assessment person was designated to work with the Fellows on assessment of student learning. When selected, Fellows are asked to agree to participate in assessment efforts to evaluate the project's effectiveness and the effectiveness of their particular course redesign.

The UC Berkeley group has experimented with how to most effectively encourage and provide incentives for the Fellows. During the pilot project Fellows received a $5,000 stipend. When the next grant was obtained, Fellows were given a stipend of $2,000, but additional funds were made available for instructional technology (up to $1,000) and library support and digitization (up to $2,000). Additional funds were also made available to departments, to help department chairs institutionalize the revised course.

The description of the project was supplemented by video footage of faculty and students discussing their experiences in teaching and learning research skills.

Elizabeth Honig, a professor of Art History, had two powerful and interrelated realizations. She saw that students wanted to do research, but that they were usually ill-prepared, and lacked requisite skills and models.

Victoria Robinson, a lecturer in Ethnic Studies, remarked how teaching research has enabled her students to see more clearly how knowledge is produced and debated. This awareness has made her students more likely to be critical, active participants in class discussions and has shifted the focus away from the instructor as the single source of knowledge within the class.

A video archive, with footage of other Fellows and students is available online at: http://library.berkeley.edu/MellonInstitute/photos.html

Challenges Ahead

Mark Feldman briefly addressed some of the challenges to scaling up research-based undergraduate education and to institutionalizing these changes. The challenges were grouped into three areas:

1) *Separation of Research and Teaching*
   Historically, research and teaching have often been imagined as unrelated or even antagonistically related faculty activities. Some possible ways to change this are:
   a) To broaden what counts as research. For instance, Ernest Boyer identifies not only a scholarship of discovery (what most of us think of as "research"), but also scholarships of teaching, integration, and service. (*In Scholarship Reconsidered*, 1990.)
   b) To change promotion policies to incentivize innovative and effective teaching. Jenkins, Breen and Lindsay, in *Reshaping Teaching in Higher Education: Linking Teaching With Research* (2003), note that "In all institution types, except the liberal arts college, the more time faculty spend on teaching, the lower their pay."
   c) To require departmental statements on how they see the nexus between their research and undergraduate learning. For instance, Southampton University in England, requires that "each academic department develop a … teaching and learning strategy … [that] will include a statement of how research [is part of] its teaching." (Jenkins et. al., 95)
   d) To have research centers be responsible for teaching at least some undergraduate teaching. This might change the perception that not teaching at all is a reward and that research is somehow incompatible with delivering innovative and high-quality undergraduate education.

2) *Scarce Resources*
   While institutional culture is one barrier to integrating research-based learning into undergraduate education, scarce resources—both time and money—are also barriers. Some suggestions for maximizing the impact of money already being spent and making optimal use of faculty time are:
   a) To require internal research grant proposals to include a statement about how this research will benefit undergraduate education. This is the practice at Earlham College, a Quaker liberal arts college.
   b) To include research-based learning in already required courses. For instance, at UC Berkeley all students take a two-semester reading and composition sequence. The second of these courses currently includes a somewhat vague research requirement. With a minimal expenditure in terms of training and pedagogical support, this requirement could be made much more robust and substantive.
   c) To minimize duplication of efforts through greater coordination among units that support educational technology, pedagogy, library research, and undergraduate research.
   d) Support faculty innovation through assistance from units that deal with pedagogy and instructional technology and by librarians. This can lessen the investment of faculty time needed to redesign and implement research-based learning in a course. It can also preserve the knowledge that various supporting units have gained working with other courses.
   e) There is the perception that research-based learning is necessarily more work for faculty. However, integrating a research component into a course is not a matter simply of adding something new to an already full syllabus. This creates too much work and

perhaps contradictory sorts of work for both the instructor and the student. Incorporating a research assignment entails reworking the course's structure and objectives. This may necessitate covering slightly less material or demanding less memorization of facts. Education research tells us that deep and synthetic learning of the sort many research-based courses strive for is best fostered by relatively light workloads and by assignments that require comprehension rather than memorization.

3) *Scaling Up*
Delivering research-based learning to more students is challenging. Some suggestions regarding how to do this:

a) Focus on large-enrollment courses. This year UC Berkeley's Library/Faculty Fellows for Undergraduate Research has targeted large enrollment courses, such as a first semester chemistry course with 1300 students and 3 lecture sections. Including a research assignment in such large courses often involves rethinking some of our assumptions about research.

b) Include a research component in already required undergraduate courses.

c) Create a breadth requirement so that all students will take a research-intensive course. Duke University has done this.

d) Make teaching and mentoring undergraduate research a factor in faculty hiring to ensure an adequate supply of faculty who can deliver research-based learning.

Pedagogy of Place

Session leader Iannuzzi shared some ideas about how to cultivate donors and raise funds to support undergraduate research. University libraries have great potential for naming opportunities and bricks and mortar projects can be recast as learning environments, as part of a "Pedagogy of Place." For instance, a historic reading room can be transformed and presented to potential funders as a dynamic laboratory for humanities research. Donations could be used to renovate the space and also to support library programs in support of undergraduate research.

Some recent examples from UC Berkeley's Library include:

- The Evelyn Chambers Research Consultation Room, a space staffed by subject and language experts who provide one-on-one consultations with students about research projects. The renovation of the space was funded by a generous gift from the Chambers Family Foundation.
- Exhibit cases that display undergraduate research in the library have been installed to highlight undergraduate research projects. The Office of Undergraduate Research is a partner in this project, and the cases and the exhibits are funded through an endowment from a library donor interested in exhibits as a form of intellectual expression.
- The Library Prize for Undergraduate Research has been established. Each year the research process of several outstanding students are recognized with awards. Students submit their final research project, along with an essay in which they describe their research process. More information can be found at: http://www.lib.berkeley.edu/researchprize/index.html. The Library uses endowment funds to pay for the project, but is currently seeking a naming opportunity.
- The Free Speech Movement Café, constructed adjacent to the Library, with a $5 million donation. The café commemorates the Free Speech Movement. The funds have also been used for the Mario Savio/Free Speech Movement Endowment for library materials and a digitized archive focusing on the Free Speech Movement. As part of the endowment, students receive support and funding to design and hold programs on social and cultural issues in the Café as part of the FSM Café Educational Program Series. More information can be found at http://www.lib.berkeley.edu/news_events/fsm-programs/

Discussion

Throughout the session there was opportunity for group discussion, with a more extended period at the end of the session during which we generated our recommendations. One participant asked whether the Fellows were predominantly faculty or lecturers. This year the split is approximately 50-50. A participant noted that students often expect to do research in the sciences, but not in the humanities.

Recommendations

- Create teams that include individuals with expertise in pedagogy, library collections, research skills and educational technology to support and implement undergraduate courses that involve research-based learning. This recommendation is based on the success of UC Berkeley's implementation teams (I-teams) that support courses funded by the Mellon Library/Faculty Fellows for Undergraduate Research.
- Use the products of exceptional undergraduate research as a visual aid or exhibit to elicit funding for research-based undergraduate learning. For example, the products of a class that has been redesigned to include a research project could be used to interest donors in funding the course's ongoing implementation.
- Create an incentive and promotion structure that more fully rewards innovative and effective teaching, in order to encourage faculty to adopt research-based undergraduate curricula. Several participants identified promotion policies as a barrier to widespread adoption of research-based learning in the undergraduate curriculum. One participant noted that it was easier to "climb Mount Everest" than to change tenure policies and recommended a parallel system that would supplement the current structure. For instance, some faculty could be hired on a tenure track for teaching and for these faculty different promotion criteria would apply. Another suggestion was to have teaching centers. Faculty interested in innovative teaching could be hired jointly through an academic department and the teaching center.
- One participant suggested fostering connections with disciplinary associations and relying on their articulations of educational best practices. For instance, the American Sociological Association has formulated curricular ideals pertaining to undergraduate research. Such guidelines could provide useful models for individuals or departments.
- One participant suggested that efforts be concentrated so that a given department would have two or three faculty members engaged in research-based education. Having only one faculty member may lead to isolation of that member, burn out, and lack of departmental buy-in.

Resources/References

Websites

1. UC Berkeley's "Library/Faculty Fellows for Undergraduate Research" project: http://library.berkeley.edu/MellonInstitute/
2. The Mellon Library/Faculty Fellowship on Undergraduate Research: http://library.berkeley.edu/MellonInstitute/Mellon_Partners.htm. For a photo and video archive of this program visit http://library.berkeley.edu/MellonInstitute/photos.html

3. Pedagogy of Place: Provides example of how funds can be used to renovate Library space to attract potential funders and to support programs for undergraduate research: http://www.berkeley.edu/news/berkeleyan/2002/08/21_nudoe.html
4. The Library Prize for Undergraduate Research: http://www.lib.berkeley.edu/researchprize/index.html
5. The Free Speech Movement Café: http://lib.berkeley.edu/LDO/fsmcafe.html and http://www.lib.berkeley.edu/news_events/fsmprograms/

Publications

1. Boyer, E. (1990). *Scholarship Reconsidered: Priorities of the Professorate.* Princeton, New Jersey: Princeton University Press, The Carnegie Foundation for the Advancement of Teaching.
2. Jenkins, A., Breen, R. and Lindsay, R. (2003). *Reshaping Teaching in Higher Education: Linking Teaching with Research.* London: Kogan Page.

Breakout Session: Expanding Opportunities for Undergraduate Research: Engaging the Professional Schools and Developing New Financial and Human Resources

Leader: Matthew Santirocco, Professor of Classics, Angelo J. Ranieri Director of Ancient Studies, Dean, College of Arts and Science, and Associate Provost for Undergraduate Academic Affairs, New York University
Recorder: Jennifer Hatleberg, Graduate Assistant, User Education Services, University of Maryland, College Park

Presentation

Research universities are distinguished from liberal arts colleges in two important ways. One is their emphases on research and graduate education, and the other is the existence of professional schools (both graduate and undergraduate) as integral components of the institution. One challenge facing research universities is to explore ways in which their professional schools can contribute to this central university mission of educating undergraduates, especially those enrolled in the arts and sciences.

Session leader Professor Santirocco began by observing the national trend toward decreasing enrollment in liberal arts programs. As Breneman observed several years ago, even stand-alone liberal arts colleges are offering fewer liberal arts degrees and focusing increasingly on pre-professional programs. This trend has important implications both for arts and sciences and professional schools.

In looking at ways to enhance partnerships between professional schools and undergraduate liberal arts programs, it is important to identify and exploit the natural opportunities that could form a basis for such partnership. If liberal arts colleges supply their graduates to professional schools, can the faculty of professional schools somehow reciprocate and "give back" to the undergraduate colleges? What are the disincentives that have hindered the formation of partnerships between professional and undergraduate programs? What appropriate partnerships could be created and what incentives can be put in place to promote these? Professor Santirocco posed these questions, opening a conversation about participants' experiences at their own universities, their reactions to others' experiences, and their questions.

Discussion

Many professional schools have faculty whose training is in liberal arts disciplines. Although the presence of these faculty creates a range of opportunities for partnering with undergraduate programs, there are numerous barriers that prevent this from occurring. The main one is the prevailing perception within professional schools that a partnership with their university's college of arts and sciences is a one-way relationship. In order for this perception to change, there needs to be a major effort to promote a more holistic view of the university, with undergraduates as full members with appropriate access to all the university's assets, including the opportunity to participate in its research mission.

A second barrier to the development of meaningful partnerships results from the often physical and ideological separation of departments and colleges within a university. Because of such separation, faculty and administrators may identify more with their school than with the university of which the school is a part. Here, again, a change in perception is required. Rather than conceiving of the research university as an aggregate of professional schools and undergraduate programs, faculty and administrators across all schools need to understand their essential connections and promote both levels of education as part of a university, participating in a common enterprise.

Session participants described current programs on their campuses, many of which involve collaboration between undergraduate departments and professional schools in related fields. The most common interactions, not surprisingly, are between biology departments and medical and dental schools since it is relatively easy to place undergraduate biology students in labs in those schools. Yet, while such placements are frequent, it is often difficult to ensure that undergraduates' research experiences in these labs are meaningfully connected to their studies. Some professional school faculty do not understand how to include undergraduates in a research project, except to use them for data input or to serve as technicians. They do not necessarily involve students in the actual research process, in part because they have never been asked to do so, nor have they been given any guidance. If biology and medical school faculty worked together to clarify the goals and desired outcomes of a research experience for undergraduates, both the professional school faculty who supervise undergraduates and the undergraduates themselves would benefit.

Creating partnerships is most difficult in fields, such as the arts and humanities, where the relationship to a professional school on campus is not readily apparent, as it is for example between undergraduate biology and the medical school. Faculty are tenured on the basis of research output, yet undergraduates in the arts and humanities often have the erroneous perception that their own work (e.g., in dance or film) is not research based. There needs to be more exploration of what research means in non-lab settings that allow students in the arts to take advantage of the resources of a research university. It would be advantageous to begin a dialog about cross-disciplinary programs for undergraduates in Honors programs and interdisciplinary settings.

Some universities are working to change the campus culture to encourage greater involvement of professional schools in undergraduate education. The greatest activity appears to be at the curricular level. At NYU, for example, one strategy of the College of Arts and Science has been to involve senior professional school faculty in teaching Freshman Honors Seminars and newly-created Collegiate Seminars (small classes modeled on Freshman Seminars but open to sophomores, juniors, and seniors). Financial "balance of trade" is less crucial in recruiting faculty into this activity than are two other factors: First, these courses enable faculty to teach their areas of interest; and second, high-level administrators lead by example, since they teach in these programs and persuade other faculty members (and their deans) to participate.

When faculty from professional schools teach undergraduates, the undergraduates benefit not only from the expertise and different perspectives these faculty offer, but they also benefit from the opportunity to develop a relationship with an individual who may be able to mentor them later in a research experience.

To take another example, the University of Texas at Austin has been developing an interdisciplinary approach to the undergraduate curriculum. Students can participate in seminars that are team taught by three faculty members from different departments, who discuss a particular topic from their varying disciplinary and professional perspectives. Faculty from professional schools are encouraged to participate.

Clemson University has also begun to make sweeping curricular changes, directing its efforts at increasing undergraduate participation in research. Administrators and faculty have been working to define what "research" means within individual disciplines and fields. The University plans to use these definitions as the basis for a new initiative in which all students will propose and complete a three-year research project (broadly defined) in order to graduate. Though faculty will be encouraged to participate in this effort, their participation is not mandatory. The hope is that once faculty members realize the increasing range of research activities in which students can become productively involved, they will see connections to their own work and interest in participating in the program will become "contagious." It is also hoped that they will see the benefits they themselves will derive from supervising students.

The formation of meaningful partnerships between professional schools and colleges of arts and sciences will not happen without encouragement and support from a university's upper administration. The administration should set the tone and provide guidelines to support cross-school interactions, but it should not issue specific directives. Faculty members need to have the freedom to establish and pursue connections in ways that are relevant to their own academic interests. One way to encourage professional school participation in liberal arts education is by mentoring new, younger faculty members. At the same time, non-tenured faculty may be reluctant to expend time on activities that are not specifically required for tenure. While there might be initial enthusiasm among some faculty, once they realize the time and commitment teaching undergraduates entails, intrinsic rewards may not be enough to mitigate "burnout."

Concern was expressed about the high cost of sustained involvement of professional school faculty in undergraduate research and whether universities can (or do) provide sufficient financial support. How can a university's resource base be budgeted to create incentives for long-term faculty participation? Clemson University was able to use a university-wide audit to reallocate $22 million, taken from inefficient applications in non-academic programs. External grants offer another means for gaining revenue, and grant applications can actually be enhanced by undergraduate participation in a project. Other revenue might come from endowments, the military, or private companies. The marketing of scholarship is a major underlying problem, along with changing expectations on the part of faculty members. Ultimately, meaningful participation in undergraduate education by professional schools will occur only when a university's leadership articulates and demonstrates by actions and budgetary allocations that undergraduate research is a valued activity and a responsibility that is to be shared by all units within the university.

Recommendations

Session participants offered several recommendations for building partnerships between undergraduate programs and professional schools. They also provided several suggestions for strategies the Reinvention Center can employ to assist in the process of change.
Promoting Partnership Among Professional Schools and Undergraduate Liberal Arts Programs:

Leadership

- University leadership must provide strong support for change in the university. While they supply the direction for change, they must not issue specific directives.

Strategies

- Promote conversations among faculty from different schools and departments, with the goal of developing interdisciplinary collaboration on research projects.
- Exploit existing centers, interdisciplinary programs, and honors programs as sites for further conversation and planning.
- Recruit "fellow travelers" in the professional schools, who share a passion for their field and are already interested in involving undergraduates in research.
- Recruit students as ambassadors who will challenge faculty to involve them in research.

Recommendations for The Reinvention Center/Conference

- Develop and promulgate an inclusive definition of research that will take into account a full range of scholarly and creative work.
- Broaden the participation in the Reinvention Center conference by:
  - Including undergraduates in oral presentations or poster sessions that describe how undergraduate research has affected their education.
  - Including organizations and publishers who produce resource materials for educators, so that they may develop a better understanding of faculty needs and ultimately provide stronger support for faculty. (Possibly investigate the chance that publishers or organizations might underwrite the conference.)
- Assist in compiling information on funding and resources.
- Convene mini-workshops or interventions between the larger conferences, to continue problem solving on specific issues. Use video-conferencing for those who cannot be physically present.

Resources/References

Websites

1. Bridging Disciplines Program at University of Texas at Austin, an interdisciplinary program that provides flexibility in choosing undergraduate coursework and research opportunities for attainment of the baccalaureate degree: http://www.utexas.edu/student/connexus/bdp/index.htm.
2. Clemson University undergraduate, multi-university research colloquium, designed to support undergraduate research projects in the natural/life sciences. http://virtual.clemson.edu/groups/SCLife/HHMI%20UR/undergraduate.htm.

Breakout Session: Forming Multi-Campus Partnerships

Leaders: Jeffrey Roberts, Professor of Chemistry, University of Minnesota at Twin Cities, and Robin Tanke, Associate Professor of Chemistry, University of Wisconsin at Stevens Point
Recorder: Amanda Nienow, Graduate Student, Department of Chemistry, University of Minnesota at Twin Cities

Presentation

Multi-campus partnerships offer the possibility of increasing the quality and quantity of research experiences that an institution can offer its undergraduate students. They also provide a mechanism for invigorating and energizing faculty members, particularly those from departments that are small or lack a research-friendly environment. The most successful multi-campus partnerships are likely to be ones that involve both primarily undergraduate and graduate degree granting institutions. The challenge is to find a way of accommodating and respecting the very different cultures found in these two types of institution. Using the Research Site for Educators at the University of Minnesota (www.chem.umn.edu/rsec) as a starting point, this session examined strategies and goals in setting up multi-campus partnerships to foster undergraduate research and enhance student and faculty experiences.

Session co-leader Dr. Robin Tanke is a professor of chemistry at the University of Wisconsin-Stevens Point, a small comprehensive university with an average of fifteen chemistry majors. Co-leader Jeffrey Roberts is a professor of chemistry at the University of Minnesota–Twin Cities (MN), a large research university. Dr. Roberts and Dr. Tanke are both involved in the partnership known as the Research Site for Educators in Chemistry (RSEC). Funded by the National Science Foundation, the partnership is designed to bring together faculty from undergraduate institutions (i.e. community colleges, baccalaureate colleges, and universities that offer master's degrees) and faculty from research universities to enhance the research and educational opportunities in chemistry at both the undergraduate and research universities. Approximately 35 undergraduate colleges are involved in the MN RSEC. The type and level of involvement by students and faculty from these institutions varies from participation in summer research experiences to replacing faculty who are on sabbatical leave. The University of Minnesota benefits from the partnerships by enriching the schools' undergraduate education in chemistry and attracting their students to Minnesota's graduate program. The other participating institutions benefit by gaining funds and other resources, by having access to experiences that are not available on their own campuses, and by getting important advice.

The session leaders posed four questions for the group to discuss:

a. What are the advantages and disadvantages of building multi-campus partnerships? What specific benefits do undergraduates gain? In deciding whether to partner with another institution, when do you say "yes" and when do you say "no"?
b. How do you ensure partner equity, especially when a broad range of institutional types are involved? How do you accommodate widely varying needs, capabilities, and resources?
c. How do you design a partnership for permanence? What are the best strategies to employ to avoid making success dependent on the leadership of one or two people? How are new leaders best recruited?
d. What are the most significant hurdles to building new partnerships? How do you convince administrators and colleagues to see value in a multi-campus partnership that provides modest financial benefits to any one institution?

Discussion

Participants had three main interests in wanting to learn about multi-campus partnerships: To learn how to overcome problems and establish real partnerships with area schools (including K-12 schools), to develop successful NSF undergraduate research centers, and to form successful relationships with the larger community. In all three instances, establishing productive partnerships requires, first, identifying the goals driving the alliances and then devising strategies for initiating and sustaining them so that they retain their effectiveness and vitality.

Partnerships provide a useful way to bring together resources from a variety of sources to solve specific problems and to build community-wide relationships. Benefits from such collective activity can be plentiful, but the road to success is often filled with challenges. Several conditions must be present for a successful partnership.

- Good relationships among prospective partners are essential. They usually begin before a formal partnership is initiated. These relationships allow for the growth of trust, respect, and knowledge of one another's programs. Through these relationships, program needs and individual strengths can be accessed. All sides can see how they themselves and their prospective partners can benefit by joining together in a formal arrangement.
- Once the decision is made to form a partnership, the specific goals of all the partners institutions should be articulated and presented to the group. Thus from the beginning, there is an openness to the process, and everyone involved in the partnership knows the goals and objectives of all participants. This openness facilitates trust among the various partners, as well as a sense of ownership. These aspects of the partnership, along with a plan of accountability and flexibility, are keys to success.
- Once goals have been identified and agreed upon and the roles of the various partner have been assigned, the first steps toward achieving the goals can be taken. As part of this process, evidence of success should be gathered and used to recruit more people and resources into the partnership. Evidence should also be used to address the issue of sustainability.

A major challenge in developing successful partnerships relates to funding. Funding is only one element of a partnership. While funding is needed to sustain and govern successful partnerships, partners must have a deeper reason to join together than funding if their programs are going to be effective and have value beyond the period of a grant. In addition, funding is often granted by agencies with specific goals that may or may not match all the goals of the partnership. It becomes important to keep all partnership goals in mind when working with agencies. When seeking funds for a specific partnership initiative, sustainability needs to be addressed. One must ask, "are we looking for an enduring program or enduring effects of a program?" At the outset, the partners must determine whether the ultimate goal is to establish a long-standing program or to produce outcomes that will benefit all of the partners. The MN RSEC, for example, is funded for five years only.

By the end of this period, members should have developed personal and professional relationships with colleagues at different participating institutions and identified successful models for more enduring collaboration. Faculty at undergraduate schools should have gained skills in writing grant proposals and starting research programs. Ideally, faculty involved in RSEC programs will be able to continue collaborative projects funded by the grant, even after the grant has terminated. Though the formal NSF-funded program will no longer exist, its effects potentially can be felt for years. For those involved with the MN RSEC, this is a positive outcome. When partnerships want to continue programs beyond the tenure of the external funding, they will need institutional support, including financial resources. The process of developing these resources should take place while the program still has its external funding. Accomplishing the partnership's goals and publicizing its successes can help in garnering continued support.

Institutions face many barriers as they attempt to form effective partnerships. A major challenge is to convince colleagues to become involved. Often, faculty and administration do not see the benefits they would derive from the association, nor do they feel that the benefits are worth the time they would be expected to commit to the project. It was suggested that skeptical faculty members and administrators be invited to join the partnership once evidence of success can be demonstrated. "Converts" often become the biggest advocates of partnership programs. A second barrier is funding, particularly after the initial grant that has supported the development of the partnership runs out. A third, more persistent challenge is establishing equity among the partners. Despite their different needs, capabilities, and resources, all partners must have a sense of ownership of the program and contribute equally, though the nature of their contributions may vary. In order to succeed, a partnership must find ways to ensure equity. There is no precise formula for this. Every partnership is likely to find its own way of balancing interests.

The session concluded with participants talking about the lessons they learned as they attempted to establish successful partnerships:

- Partnership members must be willing to travel to other partner institutions.
- Faculty and administrators at a research institution must be sure that programs offered by the partnership are sensitive to the different needs of all the partners and include an educational process through which other partners learn about such matters as obtaining external funds, writing grants, and becoming involved with collaborative projects.
- Many colleagues will become involved in a partnership program after the partnership is established and successful. Regardless of their level of involvement, they will most likely expect the faculty member or administrator who initiated the partnership on their campus to solve all of the program's problems.
- Although everyone may agree on program/partnership goals, the bottom line for participating members may differ. In a partnership made up of research universities, K-12 schools, and science museums, for example, specific program goals were set at the start of the project. When the members however started to initiate activities to achieve the goals, it became apparent that they had different interests. The researchers were concerned that the program be accurate and impart factual information. The K-12 educators had to follow educational standards, and the museums were eager to get more people through the door. Once these differences were identified, it took time and a concerted effort by numerous parties to address them. Moreover, some of the partners ultimately dropped out of the partnership.
- Equity is key to a successful partnership. All partners must see the benefits of involvement and must be involved 100%.
- A core of committed people is needed for every successful partnership, though the make-up of this core may differ widely.
- Accountability and flexibility allow for success.

Recommendations

For Individual Campuses

Session participants identified five requirements of successful partnerships:

- They must be organic and all partners must be equal.
- They must bring the strengths of all the partners together.
- Partnerships should be structured around needs, not funding. They should formalize and expand existing relationships.
- A partnership is only worthwhile if it becomes greater than the sum of the parts.
- An enduring effect of a program is not the same as an enduring program." (Dr. Stephen May). At the outset, partners must determine whether the ultimate goal is to establish a long-standing program or to produce effects that will improve all of the partners. These ultimate goals will affect funding and program/partnership goals.

For The Reinvention Center

- The Reinvention Center should compile an inventory of resources that provide models of good partnerships and partnership formation. These resources should describe successes and failures encountered while establishing partnerships.

Resources/References

Websites

1. The Research Site for Educators at the University of Minnesota: www.chem.umn.edu/rsec
2. The University of Colorado-based Coleman Institute for Cognitive Disabilities uses interdisciplinary research and multi-campus partnerships in the research and development of innovative technologies to enhance the lives of people with cognitive disabilities: http://www.colorado.edu/engineering/cue01/projects/coleman2.html and www.cu.edu/ColemanInstitute/
3. The National Science Foundation Undergraduate Research Centers (URC) Summary of Program Requirements NSF 05-539: http://www.nsf.gov/pubs/2005/nsf05539/nsf05539.htm

Breakout Session: Facilitating Effective Undergraduate Research by Graduate Students and Post-docs

Leaders: Janet Rankin, Associate Professor of Engineering and Associate Director; and Laura E. Hess, Associate Director, The Harriet W. Sheridan Center for Teaching and Learning, Brown University

Presentation

In many fields of study, success in research requires not only sophisticated experimental and analytical skills, but good mentoring and managerial skills as well. In 2001, Janet Rankin of the Division of Engineering at Brown University established the "Facilitating Effective Research" (FER) program to provide graduate students and post-doctoral students with a forum to discuss issues inherent in the effective management of research activities and the mentoring of undergraduates. The need for this program arose from the fact that graduate students and post-docs are often responsible for the day-to-day supervision of undergraduate research.

The FER program, now offered annually at the beginning of the summer, is designed to help participating graduate students and post-docs in their management roles during their time at Brown, and to help prepare them for successful careers when they enter academe or industry. Additionally, by helping graduate students and post-docs consider the issues and factors inherent in effective management and mentoring, the FER program greatly enhances the research experiences of the undergraduates.

In many science departments, graduate students and post-docs are

often responsible for the day-to-day supervision of undergraduates in laboratory and other research settings. This close working-relationship between graduate students/post-docs and undergraduates can be very rewarding for all parties, but often, the graduate students and post-docs are given little explicit guidance about planning research tasks, or how best to guide and manage undergraduate students. To help make the research experience more meaningful for the undergraduates and more rewarding for the graduate students and post-docs, the Division of Engineering (supported by the National Science Foundation through a MRSEC grant), together with Brown's Sheridan Center for Teaching and Learning, developed this week-long program. In order to make the program attractive to and logistically practical for the Division's graduate students and post-docs, the program was designed as a series of five sessions held from noon until 1:30 p.m. on consecutive days. Lunch is provided for all participants. The topics of the five sessions are: 1) Presentations of Various Extreme Management Styles, 2) Faculty Perspectives, 3) Managing Research Projects in the Industrial Sector, 4) Role-playing Scenarios, and 5) Facilitating Undergraduates in the Optimization of their Potential as Researchers. Descriptions of each session follow:

Session 1: Presentations of Various Extreme Management Styles
In order to demonstrate various extreme management styles, trained Sheridan Center Teaching Consultants assume the roles of hypothetical characters such as: "The Control Freak," "Dr. Overextended," "Prof. Disinterested," and "Prof. Hypersensitive." Participants discuss the positive and negative attributes of each of the characters presented and consider how undergraduates might perceive the statements, actions and attitudes of each character. They then are asked to identify their own management styles and to explore the impact that these styles may have on co-workers.

Session 2: Faculty Perspectives
Faculty from the Division of Engineering offer their perspectives on advising, including their own graduate school experiences and the ways in which their "management/mentoring styles" have changed over time. By considering the faculty experiences, participants begin to think critically about mentoring relationships, and learn how to respond constructively to difficult situations.

Session 3: Managing Research Projects in the Industrial Sector
Adjunct faculty from the Division of Engineering, who are currently working in industry, and faculty who have previously done so, offer their perspectives on the similarities and differences between managing research in industry and in academe.

Session 4: Role-playing Scenarios
Participants act out a variety of scenarios involving hypothetical graduate– undergraduate student interactions and reactions to a variety of problems and issues that can arise in a research setting. Through these role-playing activities, students develop a better understanding of undergraduate perspectives on issues of advising and management, and learn how to address advising/management issues as they arise.

Session 5: Facilitating Undergraduates in the Optimization of their Potential as Researchers
Based on their own experiences and the previous sessions, participants discuss how to best motivate and coach undergraduates possessing a variety of abilities, learning styles and personalities. Participants also discuss organizational logistics such as long and short term planning, contextualizing research tasks within larger research objectives and goals, establishing and maintaining a group meeting format and dealing with "unexpected" situations. In addition, program evaluations are distributed and collected during this session.

Although the FER program was developed for Brown's Division of Engineering, it can be easily adapted for a wide variety of disciplines. The objectives, discussion questions and all related materials for each session are available at: http://www.brown.edu/Departments/Advanced_Materials_Research/

Discussion

There was considerable interest in expanding the FER program across the disciplines and, in particular, establishing a program like this for the humanities. The group considered what alterations would need to be made to create an effective format. In the humanities, the main obstacles are the individualistic nature of research and the funding structure, which means that graduate students rarely have the opportunity or need to oversee undergraduate research.

Participants considered ways in which the program could be adapted to address the needs of non-native English speakers. The group was particularly interested in learning how the FER program deals with potentially sensitive issues that arise in cross-cultural advising and mentoring. It was suggested that campuses and/or departments could initiate a FER-like program specifically tailored to the needs of graduate students who are non-native English speakers.

The group debated whether graduate students should, in fact, be the primary research contacts/advisors for undergraduates. Some participants felt that undergraduates benefit more from research experience when they are directly overseen by faculty members. In defense of a system where graduate students are the primary undergraduate research supervisors, some participants observed that graduate students are actually closer in age and world-view to undergraduates, and are consequently more likely to form successful research partnerships. In addition, it was noted that good mentoring by graduate students is better than poor, or no mentoring from faculty members.

Members of the group observed that in most science disciplines it is relatively easy to involve undergraduates with strong academic records in research activities. Students who perform well in a particular class often approach the instructor to inquire about research opportunities. It was noted that students with less than optimal grades, as well as high-performing students from less privileged socioeconomic groups, are less likely, to seek out faculty members in general, and to inquire about undergraduate research opportunities, in particular. The group discussed strategies for reaching out to a broader group of students when faculty are hiring for summer projects. A member of the group described how he announces in large lecture classes undergraduate research opportunities for the summer/academic year, and also holds open houses so that students do not have to approach faculty on their own about such opportunities. Participants suggested that once undergraduates have been hired, they be assigned to work in pairs in order to minimize any sense of intimidation they might feel.

Recommendations

<u>For Individual Campuses</u>

- Universities that do not have programs like FER should establish them.
- Universities with similar programs should expand them to include graduate students from a wider range of disciplines, particularly the humanities.
- International graduate students should be encouraged to participate in FER-like programs.
- Campuses should sponsor forums at which undergraduate and

graduate students who have benefited from these kinds of programs share their experiences with faculty and offer perspectives on program efficacy.
- Undergraduates should be invited to participate in at least one of the FER programs sessions so that graduate students and post-docs can learn more about the undergraduate perspective.

For The Reinvention Center

- Faculty are encouraged to consider specific gender and cultural issues which might arise in multicultural education, and to develop FER-like programs or sessions to address these issues. The Reinvention Center can play a role in facilitating discussions on these issues.
- Graduate students who have participated in the FER program should be invited to the Reinvention Center's annual conference to share their perspectives on the efficacy of the program.

Resources/References

Website

Center for Advanced Materials Research at Brown University
http://www.brown.edu/Departments/Advanced_Materials_Research/

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Hess_Rankin/Powerpoint.pdf

Breakout Session: Increasing Engagement and Retention Through Research and Creative Endeavors

Leader: Pedro Castillo, Professor of History and Provost Oakes College, University of California at Santa Cruz
Recorder: Marianne Bueno, PhD Candidate, Department of History, University of California at Santa Cruz

Presentation

Session leader Castillo began this session on increasing undergraduate engagement and retention through research and other creative efforts with a presentation on a research-oriented first-year core course implemented at Oakes College, one of ten residential colleges at the University of California at Santa Cruz (UCSC).

Oakes College has 1,200 undergraduate, of whom approximately 300 are in their first year. The College is one of the most ethnically diverse of UCSC's ten colleges, with a population that is 30% Euro-American and includes the largest number of African American among all colleges, a sizable number of Latino students and large numbers of Asian and Native American students. About half, or 600, of the students live in the residential buildings at Oakes. The USCS colleges are also home to academic departments. The academic departments housed at Oakes College include American Studies, American Literature and World Literature. The graduate program in the History of Consciousness also resides there.

When Professor Castillo became Provost of Oakes College three years ago, he had among his goals to enhance students' multicultural understanding and foster cross-culture perspectives, and to increase undergraduate engagement and retention. He was able to bring these goals together by taking advantage of the UCSC requirement that all first-year students take a core course and a writing intensive seminar in their first quarter.

At Oakes College, the writing-intensive core course offered during the Fall Quarter and the research seminar during the Spring Quarter are connected and designed to reflect the multi-ethnic backgrounds of the students and faculty and the College's emphasis on cross-cultural understanding. The theme of the core course is "Values and Change in a Diverse Society." Through readings of fictional and non-fictional works that speak to changes taking place in American society, students examine historical and contemporary aspects of multiculturalism in the United States, including issues of inequality in the areas of race, class, and gender. The knowledge gained through the reading and writing of the core course are reinforced during the Spring Quarter's research seminar entitled "Race Relations in Modern America – Humanities and Social Sciences," in which they write papers that require research and reflection on subjects discussed in the core course.

While all 300 first-year students at Oakes College take the core course and writing seminar, Oakes also developed complementary seminars designed to involve smaller groups of first-years students in core-related research and creative activity in different venues. During the second quarter, students may choose to take a seminar centered on service learning; in the third quarter, they can take a discovery-oriented research seminar based on the core course theme, with an emphasis on race relations in modern America.

Students must apply to participate in the service learning seminar, which can accommodate fifty students (two sections of twenty-five students each). The service learning seminar has two components. First, the students are all placed at a government office or non-profit organization in the community where they carry out a research project. Projects thus far have involved politics, education, poverty, housing, social services and government work. In addition, as part of the experience, they are supervised by faculty sponsors who work with them on developing skills in critical thinking, field methodology and the practical application of theory. In determining the students' sponsors, the College attempts to identify faculty whose work relates to the individual student's placement or who have research interests or disciplinary knowledge that match the student's intended focus. A student working in a museum, for example, might work with a history professor; a sociology student placed with the local chapter of the NAACP might work with a professor whose teaching and research interests are in social inequality; a psychology student assigned to a soup kitchen or women's shelter might work with faculty interested in gender, psychology and poverty. Obtaining a good match is important because the students are not placed in the community to do clerical work; they are there to conduct research supervised by the faculty.

The second component is the seminar itself, taught in a classroom setting, usually by a faculty member in sociology or psychology. The combined approach of seminar plus placement works well because the placement not only validates the students' classroom experiences, but it also allows the students to understand and make connections between social, political and economic issues learned through course work and local community life—in other words, to bridge the gap among academic studies, research and service work.

The third quarter research seminar associated with the "Values and Changes in a Diverse Society" course is derived from the core course theme focusing on race relations in modern America and is entitled "Race Relations in Modern America—Humanities and Social Sciences." Like the service-learning component, it too accommodates fifty students, who are divided into two sections, each with twenty-five

students. Enrollment is limited to undergraduates who are members of Oakes College. Faculty affiliated with departments housed at Oakes, as well as faculty from other colleges and departments, teach the seminar. After an initial exploratory period, students choose a research topic they would like to pursue. It typically is in an area of history, sociology or literature. A critical aspect of the research seminar is Oakes' College collaboration with the interdisciplinary History of Consciousness graduate program. Using funds made available by the University, Oakes College and the Graduate division, Oakes College has established the Oakes/History of Consciousness Teaching Fellowship, awarded annually to a doctoral student in the History of Consciousness program to be in residence at Oakes for two academic quarters. The Fellowship is designed so that the graduate student has considerable time during the first quarter to devote to writing the dissertation; the sole other responsibility during this period is to prepare a course of general interest, which she or he teaches the following quarter. Graduate students find the fellowship valuable because it affords them time for writing and at the same times gives them experience designing and teaching an undergraduate course that has research at its foundation.

The departments that are housed at Oakes are involved in the "Values and Change in a Diverse Society" course. Affiliated faculty also sponsor students during the service learning quarter and teach the research seminars, while graduate students teach as lecturers for the core course.

Results have shown that the seminar approach used in conjunction with the "The Value and Change in a Diverse Society" course increases the engagement of first-year students. Other seminars taught by faculty in the departments housed at Oakes and offered during the sophomore, junior and senior years give students the opportunity to continue to be engaged in the educational and research processes and develop enhanced skills. Among students in the junior year who took the "Value of Diversity" sequence three years ago, 49 of the initial 50 students are still enrolled in their sophomore or junior year, when they declare their majors, and they are continuing to work with a faculty member. In addition, when faculty members are able to secure external funding to conduct research, they tend to seek out a student with whom they worked through the Oakes program to be their research assistant.

The financial cost of the Oakes effort is minimal, though it does require quite a bit of coordination among the provost, department chairs and faculty members. Nonetheless the undergraduate students have a very rich first-year experience. The commitment to the Oakes students continues once they declare a major, regardless of the discipline they choose.

The Oakes College emphasis is on students in History, Art and the Social Sciences. Science is not emphasized because underrepresented students in the sciences have access to support via a number of programs aimed at increasing underrepresented students in the sciences.

Discussion

Much of the discussion focused on the Oakes College program. Questions were raised about a range of topics, such as the residential colleges at UCSC and the communal experience the residential college system offers; the retention rate of the Oakes College program; the narrative evaluation system used at UCSC; the relationship between faculty and students and how that affects the narrative evaluations; how the Oakes College program attracts faculty members to work with students in the program; the nature of the compensation ($1,000 or a course release) given to affiliated faculty; how the placement of students in local community organizations is facilitated (a database is kept the Oakes program assistant); other undergraduate programs at UCSC that emphasize research (programs with this emphasis are offered by the Community Studies and Economics department as well as by Merrill College); the training of the Oakes program undergraduate students in research methodology; and the implementation of a more in-depth assessment of the Oakes College program.

The group also considered issues members of the audience face at their universities. Topics broached in this part of the discussion included: reports on similar programs at other institutions (First-Year Discovery Program at the University of Kentucky, Field Work Program at the University of Connecticut); strategies used to reach a diverse group of students for undergraduate research programs (staggered enrollment); the recruitment of faculty to participate in undergraduate research programs (faculty accountability vs. financial bribes); the cost of offering these kinds of programs; issues of course releases; how to engage the less assertive students who might benefit more from programs such as faculty/student mentoring programs and research programs; how to reach diverse groups of students; the different level of responsibility between teaching and working with undergraduate and graduate students (teaching undergraduate courses vs. chairing a dissertation committee); decreased state funding of universities/colleges and a concurrent increasing emphasis on faculty pursuing external funds; and the tenure promotion system and mechanisms of reward (publish or perish, increased scrutiny of workload – time in the classroom vs. research and advising time). Members of the group noted that, in comparison with their colleagues in laboratory sciences, faculty in the social sciences and humanities find it difficult to get grants; this leads to fewer efforts like the Oakes College core course and accompanying seminars that are directed primarily at students interested in majoring in a social science or humanities discipline, and it affords these students limited research opportunities. It was suggested that universities use the indirect costs received from external grants to address this problem. It was also urged that universities make undergraduate research in these disciplines a priority in capital campaigns.

Recommendations

- The most "crucial" recommendation is for campuses to reevaluate the tenure promotion system. Though teaching, service work and publishing are all part of tenure evaluation the unspoken emphasis at virtually all universities is on research and publishing. With the emphasis on publishing and the rising teaching load across the country, it is harder to persuade faculty members to participate in programs that focus on increasing the engagement of undergraduates and integrating research into undergraduate education.
- Universities need to develop mechanisms to recognize and reward the kind of faculty participation that the Oakes program and other initiatives directed at undergraduates entails. Such mechanisms would go a long way toward alleviating faculty discontent and attracting more faculty. Suggested strategies include: increasing possibilities for teaching more narrowly focused courses; buying of release time; and acknowledgement and recognition of the "real" workload of faculty members (weekend and summer work outside of the classroom).
- University leaders should undertake a major evaluation of teaching loads, with special attention on inequities that may exist.

The Reinvention Center could play a lead in fostering discussion of these issues and working with member institutions to establish common standards.

Resources/References

Websites

1. Esprit de Corps: College Nine's Service-Learning Course in which students earn credit in exchange for a volunteer commitment and attend a weekly seminar: http://collegenine.ucsc.edu/praxis.shtml
2. Praxis: College Ten's Service Learning Course: http://collegeten.ucsc.edu/praxis.shtml
3. Alternate Spring Break, an opportunity for students to engage in community service and experiential learning during Spring or Summer breaks: http://www2.ucsc.edu/institute/community/alt_break.shtml
4. Student Volunteer Connection, a student-run organization designed to bridge student involvement in the Santa Cruz community through meaningful volunteer opportunities: http://www2.ucsc.edu/institute/community/svc.shtml
5. The UCSC Center for Teaching Excellence: http://ic.ucsc.edu/CTE/index.html
6. The History of Consciousness Program, an interdisciplinary graduate program centered in the humanities with links to the social sciences, natural sciences and the arts: http://humwww.ucsc.edu/histcon/HisCon.html
7. "Values and Change in a Diverse Society" the Oakes College's core course for first year students: http://oakes.ucsc.edu/
8. The University of Kentucky's Discovery Seminar Program for first year students: http://www.uky.edu/AS/Discovery/index.htm
9. The Freshman Discovery Seminar Program at the University of California, Riverside: http://discoveryseminars.ucr.edu/index.php
10. The UCSC Freshman Discovery Seminars: http://planning.ucsc.edu/vpdue/froshseminars/
11. The UCSC Community Studies Department offers an interdisciplinary undergraduate (and graduate) program that focuses on the study of social change in the context of the community. http://communitystudies.ucsc.edu/

Breakout Session: Research and Creative Activity: Critical Components of a Sound Liberal Arts Education

Leader: Sue V. Rosser, Professor of History, Technology, and Society and Dean, Ivan Allen College of Liberal Arts, Georgia Institute of Technology
Recorder: Richard Barke, Associate Professor, School of Public Policy, and Associate Dean, Ivan Allen College of Liberal Arts, Georgia Institute of Technology

Presentation

Liberal arts students and faculty engage in learning and research across a wide variety of fields, disciplines, pedagogical styles, and research traditions. The perspective of a liberal arts college at a technological university such as Georgia Tech underscores many of the opportunities and challenges that confront researchers in the humanities and social sciences. This perspective also highlights the importance of adjusting our educational institutions and practices to accommodate the increasing priority being given to involving undergraduate students in the research process.

Institutional Context

Georgia Tech is a public research I technological institute of higher learning. Its president, Wayne Clough, has endorsed the Institute's evolution into a "leading technological university for the 21st century," leaving many decisions about operationalizing that goal to the Georgia Tech faculty. Perhaps most important to understand about the Georgia Tech context is that there are countervailing forces at work on processes of change: a strong sense of tradition, rooted overwhelmingly in the engineering, architecture, and science fields, but at the same time a strong spirit of entrepreneurialism which encourages faculty and students to explore new options for research and education. One indication of the willingness of the Institute to change is its reorganization in 1990 which created the Ivan Allen College, encompassing the social sciences and humanities, and several undergraduate degree programs; there are now eight, including a joint degree with Georgia Tech's College of Computing. Ivan Allen College includes six schools:

- Economics
- History, Technology, and Society
- Literature, Communication and Culture
- Modern Languages
- Public Policy
- Sam Nunn School of International Affairs

The university currently has more than 16,000 students, about two-thirds of whom are undergraduates. The student body has very high abilities, with average SAT scores of 1337 in 2004. Although Georgia Tech is a public university (part of the 34-unit University System of Georgia), about forty percent of the students are from out of state, and about one-fifth of the total student body are international students.

Diversity is a particular challenge at a technological institute. Three-fifths of Georgia Tech students are engineers, and students in computing and the natural or physical sciences comprise another twenty percent of the student body. Only six percent are liberal arts majors, but 58 percent of these majors are women, compared with thirty percent of the entire undergraduate population. Georgia Tech produces the largest number of African-American and women engineers in the US.

A central part of Georgia Tech's character is its strong emphasis on research. New research awards in FY 2004 were $342 million, with research expenditures of $425 million. Much of this research is focused on the development of practical technologies; the Institute produced 277 invention disclosures in 2004.

Although the expenditures in liberal arts research are much less than in engineering research, Ivan Allen College is part of Georgia Tech's strength in this area. From FY 03 to FY 04 the number of grants submitted through the Office of Sponsored Programs grew from 31 to 52. In FY03 three IAC schools submitted grant applications; in the most recent year, faculty from all six schools (plus the Dean's Office) applied for external research grants, and the amount of new awards grew from $4.651 million to $5.775 million – a 24 percent increase in a single year. Most of this increase is attributable to the hard work and creative ideas of the 130+ tenure-track faculty of course, but it also reflects several initiatives by the College (such as grants workshops) to encourage and expedite the grants process. Altogether, at least 46 IAC faculty from all units of the College were awarded internal or external grants to assist their research and education activities.

These grants, along with other research that was conducted without external funding, covered a wide range of topics, reflecting the diversity of IAC faculty research interests. Nevertheless, most of this research directly connects the liberal arts fields to the mission of Georgia Tech: "to provide the state of Georgia with the scientific and technological knowledge base, innovation, and workforce it needs to shape a prosperous and sustainable future and quality of life for its citizens." Those objectives clearly require an awareness of the social, cultural, economic, ethical, and political consequences and determinants of scientific and technological change.

Reflecting Georgia Tech's strong interest in undergraduate research, Ivan Allen College is a vital part the President's Undergraduate Research Award (PURA) program. Undergraduates can propose research projects, working with individual faculty, and receive a stipend or travel expenses to attend professional conferences to present their research. Although liberal arts majors in Ivan Allen College comprise only six percent of the student population, in recent semesters IAC projects have received the second-largest amount of PURA funds. It is notable, however, than many liberal arts research projects are devised by students majoring in engineering, computer science, and the natural sciences who are sponsored by IAC faculty.

Examples of recent undergraduate PURA research projects in IAC include:

- Software Release and Growth
- International Airline Alliances: Smoothing a Turbulent Industry?
- Protest Behavior and Causal Factor-Case Study: School of the Americas
- Overseas Direct Assistance: The Nexus of Private Aid and Executive Strategy
- Combating Sex-Trafficking from the Ukraine and Moldova
- The Complexity of Eighteenth-Century Midwifery in Tristam Shandy
- Exploring the Role of Science Fiction on Indian Culture
- Academic Patenting and Publishing: Substitutes or Complements?
- The Larceny of Listening: The Digital Music Technology Revolution in Atlanta
- New Media and Politics: Local Social Movements' Use of the Internet
- The Cycle of Homelessness of Women in Atlanta

Many Georgia Tech students, including liberal arts students, choose to participate in undergraduate research for course credit rather than pay; the Institute's policies discourage schools from granting both.

Finally, as part of the Quality Enhancement Plan mandated by the accrediting body for the region the Southern Association of Colleges and Schools (SACS), Georgia Tech is considering a sizeable increase in its already-significant level of undergraduate research by offering a degree designation ("Research Plan") to students who complete three semesters of undergraduate research (at least two semesters on the same project) and a thesis or other substantial written report. A campus-wide course on "Writing an Undergraduate Thesis" would be developed, although schools and colleges could choose to offer their own preparation. Furthermore, the Institute would develop a new Undergraduate Research Opportunities Program to coordinate campus-wide activities, and to help track and maintain high-quality research experiences for undergraduates. These proposals will be considered by the Georgia Tech faculty in Spring 2005.

Discussion

Issues in Undergraduate Research

There is abundant evidence that meaningful participation in discovery-driven activities such as undergraduate research is likely to be of great benefit to students. It provides a new way of learning in a field of study, and by being part of a discovery team students acquire not only experiential learning but also improved capacities to work and communicate with others. These skills help students prepare for possible continuation of studies in graduate or professional school, as well as give them a basis for deciding whether the life of the researcher is what they want. Clarification of career goals points students in the right direction and motivates them to pursue their undergraduate studies with more focus and energy.

The discussion focused on questions of implementation and structure. Several questions were posed to the participants, leading to discussions and often further questions as well as answers based on experiences at a variety of colleges and universities.

- "Where are the structural supports in your institution for undergraduate research?"

Possible examples were mentioned, including support at the institutional level (such as Georgia Tech's PURA) program, funding from private donors at the college or school level (such as a $50,000 grant to support undergraduate research in IAC), individual faculty grants (including Research Experiences for Undergraduates, or REU, grants from NSF), and the granting of course credit for research participation.

The position of undergraduate research activities and support offices in the university's institutional structure was deemed extremely important by the participants. In the case of Georgia Tech, the effort has been endorsed by the President (through his funding of the PURA program) and the entire Institute (through its central role in the SACS reaccreditation process). Top-down support is not enough, however. As many participants observed, it is vital for the university's leadership to endorse and provide resources for undergraduate research, but the most important impetus is from faculty and students.

The discussion of this topic blended with another question:

- "What is the overall climate for research at your institution, and how does this impact the climate for undergraduate research?"

All universities and colleges value research, of course, but the emphasis on research as a major component of faculty and student efforts does vary. Much of the discussion on the climate for research focused on how undergraduate research support is affected by incentives or disincentives in the tenure and promotion process. It was generally agreed that universities have not yet found a reliable way to assess a professor's contributions toward the advancement of knowledge by mentoring undergraduate researchers, nor is it easily assessed by the tools routinely used to evaluate teaching performance and effectiveness. A major challenge in the development of undergraduate research in higher education will be for universities to invent appropriate rewards for faculty who undertake what can be a very time-consuming role as a mentor to student researchers.

A lively discussion involved the dissemination of findings from undergraduate research, and the benefits that can and should accrue to the sponsoring professor. It was agreed that such research requires a public face, in the form of outlets such as peer-reviewed journals (perhaps reviewed and published by the students, but preferably reviewed and published in the same journals in which faculty publish). Some argued strongly against student research journals, claiming that they unnecessarily suggest a lower standard. Whatever the outlet, however, it was agreed that the sponsoring professor should receive recognition; some argued that sponsorship of an undergraduate research project which produces a publication in a standard peer-reviewed journal should count as a publication for that professor's promotion and tenure.

The problem of appropriate rewards for faculty efforts in undergraduate research may lead universities to find other mentors. The point was also made that institutions should avoid using graduate students or adjunct faculty as sponsors of undergraduate research. Many colleges that promote undergraduate research do not have doctoral programs, and masters-level students are not likely to be effective mentors for this

activity. Students need to learn professional practices (research, communication, negotiation, etc.) from faculty with substantial experience in the research enterprise.

Participants described the challenge in finding a single rationale for undergraduate research, particularly regarding the relationship between intellectual and vocational justifications for supporting undergraduate research. To some, it may appear to promote "careerism" and a narrow focus on research as a device to improve career objectives, but the importance of such experience for shaping a student's future path is inarguable. Still, there was a consensus that research, even at the undergraduate level, should be driven more by curiosity and a desire to learn than by a narrow calculation of steps toward a particular occupational objective.

- "When is it appropriate to give course credit and/or pay for undergraduate research?" A related question was "How does research differ from internships or independent study?"

Quite a bit of discussion revolved around the appropriate model for student participation in research. Some argued that without incentives or compensation, the most that could be expected of many students is to work in a laboratory, perhaps in a merely menial role, and absorb some of the research practices of faculty and graduate students. For students working with junior faculty, there is a practical limit to how much involvement can be expected from the professor. Others found such a model to be insufficiently challenging. More common ground was found on whether course credit and stipend should be linked, with most describing their university's policy as discouraging students from receiving both. It was agreed that, in practice, it can be very difficult to distinguish an internship from a research experience, and that decisions on such matters probably are best left to faculty or schools.

- "Who initiates undergraduate research: faculty or students?"

It was widely agreed that students should initiate their research projects, based on their own interests and career plans. This question led to a discussion of the role of faculty as initiators, supervisors, and possibly even interferers in undergraduate research. Many examples were offered to demonstrate the myriad ways in which students and faculty identify common interests and initiate their joint activities, or in which students are encouraged and supported to conduct independent research.

- "What are the particular challenges facing undergraduate research in the humanities and social sciences?"

Some participants reported that natural scientists at their universities are skeptical of the use of the word "research" by faculty or students in the liberal arts. Some campuses have had meetings or workshops to introduce humanities research to others on campus, in the hope of changing the climate regarding non-science/engineering research. "Creative work" can sometimes be a synonym for research, depending on the field or discipline. Brigham Young University's research office is called "The Office of Research and Creative Activities," indicating a breadth of efforts that can be encompassed. The group felt that appropriate diversity in considering "research" requires an emphasis on rigorous and focused creativity, whether in scientific or non-scientific realms.

The discussion also raised the point that students can be confused about what is meant by "research" (and that if faculty and administrators find it difficult to define precisely, so will students). Some universities, the University of South Florida for example, encourage or require everyone who receives institutional research funding to attend presentations at which many types of research and creative work are portrayed. Similarly, it is important that the institutional body that allocates research funds—whether to faculty or to undergraduate students--include members with sufficient expertise to assess research and creative activities across the university's array of fields and disciplines.

An important by-product of promoting a wider perspective on research is the recognition that many disciplines actually converge in the study and analysis of many questions. An example raised by one participant was relevance of health and safety knowledge in art studios where exposure to paints and other chemicals may be common, and where knowledge of chemistry and toxicology would be needed, and where engineering solutions such as the installation of fume hoods may be appropriate.

- "How do undergraduate research programs relate to other university initiatives, such as internships, study abroad, and honors college programs?"

Time constraints at the session did not allow in-depth discussion of this question. Several observations were made, however, that illustrate the challenge in coordinating several other university functions with undergraduate research. One participant noted that "to do materials science and engineering is to do research," so a student co-oping in that field can justly claim to be doing research as well. It was also noted that institutions have difficulty in assessing and recognizing student efforts when they are outside their field of study, yet participating in research in an outside field is to be strongly encouraged. And several universities represented at the session (Ohio State University and the University of Michigan) were described as allowing both credit and pay, at least in the form of merit scholarships which are likely to explicitly require students to participate in research as a condition of the award.

In summary, at the end of the session there was a strong expression of need for more study on various universities' systems for providing credit or pay for undergraduate researchers (including how these systems affect the behavior of students, faculty, and the institutions), as well as a need for more understanding of how faculty can be properly compensated for the time and effort they devote to undergraduate research.

Recommendations

- Research should be defined broadly enough to include areas of creative and reflective endeavor undertaken with rigor and focus to generate knowledge. It must include entering a public conversation about the knowledge.
- Undergraduate research needs to include transmission of what constitutes research and creativity and its methodologies in diverse disciplines.
- Undergraduate research needs to be integrated into and supported by all levels of the institutional structure, with particular attention to its codification and validation with reward and incentives structures, including tenure and promotion.
- Institutions should avoid using graduate students or adjunct faculty as sponsors of undergraduate research, in order to allow them to learn professional practices such as research and communication skills from experienced faculty.
- More study is needed on how universities and colleges provide undergraduates with academic credit or pay for research activities.

Resources/References

Websites

1. Strategic Plan of Georgia Tech: http://www.gatech.edu/president/strategic-plan.html
2. Georgia Tech's Degree Programs: http://www.iac.gatech.edu/students/degpro.html
3. The Liberal Arts College of Georgia Tech: http://www.iac.gatech.edu/schools/index.htm
4. Georgia Tech's Institutional Research and Planning: http://www.irp.gatech.edu/03_FB_PDF/fb_2003.html
5. Georgia Tech President's Undergraduate Research Award (PURA) program: http://www.undergradresearch.gatech.edu/institute-wide.htm
6. For examples of recent PURA projects see: http://www.iac.gatech.edu/students/research.html
7. Office of Research and Creative Activities at Brigham Young University: http://orca.byu.edu
8. Office of Undergraduate Research and Creative Activities at the University of California, Santa Barbara: http://www.ltsc.ucsb.edu/urca/
9. Office of Undergraduate Research and Creative Activities at Michigan State University: http://www.urca.msu.edu/
10. Office of Undergraduate Research and Creative Activities at Stony Brook University: http://www.sunysb.edu/ureca/

POWERPOINT PRESENTATION
www.sunysb.edu/Reinventioncenter/Conference_04/Rosser/Powerpoint.pdf

Breakout Session: Strategies for Effecting Rapid Translation of Ongoing Research into the Curriculum

Leaders: David Lynn, Howard Hughes Medical Institute Professor and Asa Griggs Candler Professor of Chemistry and Biology; and Dawn Comeau, Graduate Student, Department of Women's Studies and Rollins School of Public Health, Emory University
Recorder: Dawn Comeau

Presentation

A research university is founded on the premise that the best researchers make the best teachers. However, the divide between research advancement and undergraduate instruction are often in conflict, and this struggle impedes access to the diverse resources offered by the institution. This session considered two questions:

- How best to intellectually center the entering college science student?
- How to intellectually empower graduate/postdoctoral students in university instruction?

Both questions are conceptually addressed by unifying the university's graduate and undergraduate educational missions.

The presentation centered on an innovative freshman seminar entitled ORDER (On Recent Discoveries by Emory Researchers), developed by session leader Lynn, with support from the Howard Hughes Medical Institute, in an effort to unify undergraduate and graduate education in ways that strengthen both.

Background

At Emory, and most research universities, graduate and undergraduate education are separate and disconnected. Several factors underlie their separation:

- Graduate student appointments are limited by the number of undergraduate teaching lines
- First-year graduate students generally TA early science courses
- Graduate and undergraduate student interactions are limited to independent research
- Few undergraduates take graduate-level courses
- There are separate seminars for graduate students and undergraduates
- There can be separate faculty for graduate and undergraduate education

The separation is also driven by federal funding for research.

Yet, both graduate and undergraduate education would benefit from increased interaction.

- Advanced graduate students need to develop skills in presenting their discoveries coherently beyond their specific discipline.
- Undergraduate freshmen must capture intellectual opportunities and resources at the institution quickly.
- Unifying the graduate and undergraduate missions would effectively empower both groups by celebrating graduate/postdoctoral student discoveries in a setting where undergraduates can hear about them.

ORDER

ORDER is a freshman seminar course taught in five modules, each given by a graduate/postdoctoral student in a natural or social science on his or her individual research findings/discoveries. The course is unified through the larger scientific issues that cut across the natural and social sciences, yet diversified by the specific discoveries of resident graduate/postdoctoral scholars across these disciplines.

The key features are:

- Five modules centered on research discoveries. Students are walked through a discovery made specifically by Emory graduate/postdoctoral scientists: the underlying question, selection of the system, experiments and controls are placed in context. The undergraduate's final assignment is to design an experiment to test a scientific question selected by the student.
- Emphasis on interactive lessons and connectivity. This emphasis is particularly important because the course is directed at incoming freshmen with no pre-requisites in science. The graduate and postdoctoral students need to find creative links between concepts in modules, bringing students to the forefront of research discoveries at Emory and in the scientific community.
- Campus-wide competition to present "Origins of Order." The graduate and postdoctoral students who teach the modules are chosen through a campus-wide competition. In the first round, there were 76 applicants from all natural science departments (biology, chemistry, physics, math/CS, psychology, pharmacology, school of public health, etc.). A committee, composed of faculty and students, selected ten from this group. Emory departments committed an additional $50K to cover the costs of five applicants. Two separate courses were developed over the summer of 2003.

The theme of one of the 2003-2004 courses was "What is Your Question?" The course consisted of the following modules:

Module 1: "How can fungus help in our understanding of cancer development?" Brenda Minesinger, Biology

Module 2: "How does air pollution affect pulmonary health?" Steven Girardot, Chemistry and Public Health

Module 3: "What do peanut butter, silly putty, sand, and shaving cream have in common?" Dr. Piotr Habdas, Physics

Module 4: "How can worm stem cells help to heal human diseases?" Christine Schaner, Biology

Module 5: "How do monkeys deal with stress?" Jason Davis, Psychology

A 2004-2005 course had as its theme "Quality of Life:"

Module 1: "Work, Stress, & Well being" Lauren Rauscher, Sociology

Module 2: "Using Neuroanatomy to Understand Neurological Disease" Dinesh Raju, Neuroscience, MD/PhD

Module 3: "Surfactants" Mary Chlebowski, Chemistry

Module 4: "Language and the Developing Brain" Elizabeth Lewis, Psychology

Module 5: "Anthropological Sensibility" Joanna Davidson, Anthropology

In all the modules, the real discoveries made by the graduate and postdoctoral researchers serve as a basis for interactive learning. Activities, for example, have included:

- Designing a suit safe for chemical warfare
- Taking classmates' brain images by EEG
- Testing if UV light is harmful to fungi like it is to humans
- Observing molecular self-assembly and order
- Finding out if "solid" or "liquid" accurately describes shaving cream, ketchup, and peanut butter
- Measuring pollution levels on campus with access to CDC analysis
- Diagnosing the main character in "Memento"
- Building a scale-accurate muscle out of bungee cord
- Creating gene-modified fluorescent round-worms
- Taking a trip to the National Yerkes Primate Research Center to observe primate/human behavior

In the two years in which ORDER has been offered, session leader Lynn and his colleagues have made several discoveries. They have found that:

- Entering student can write a research proposal; they understand scientific method.
- The seminar is an excellent forum for celebrating graduate/postdoc students' discoveries for entering students.
- The seminar expands opportunities for graduate students to have mentoring role in the classroom.
- The seminar unifies the educational opportunities of graduate and undergraduate students alike.
- The seminar bridges natural and social science departments' research.
- The discoveries that drive the graduate students' instruction facilitate students' making intellectual connections.

The breakout discussion will be seeded by the challenges faced in starting the course, our attempts to assess successes and limitations, and by challenges for the future in light of our assessment.

Audience Questions

Does the PI agree to allow the grad student to take on this responsibility with all of their other obligations?

David: Well, that is a good question. It depends, but certainly the PI needs to feel like it is worth his or her time to allow their grad student time away from the lab in order to participate in this program. In the natural sciences, we pay the $5,000 stipend directly to the PI to cover their time away from the lab. However, for the grad students in the social sciences, it is a little different. They are not working for a PI, and their stipends which come from the grad school, are for only nine months – they only cover the school year. So, they use their $5,000 stipend as summer funding.

Cost-effectiveness of paying stipend: Does this produce competition with other TA positions? Who TAs other courses?

This position is not really the same as a TA position, at least in Chemistry where freshmen graduate students teach freshmen college students. In this program, the grad students are completely in charge of developing their own curriculum, and teaching and evaluating the students. In Chemistry the TA is a subservient position, responsible for assisting with the professor's curriculum, and often this means leading the labs, but not much teaching. They aren't involved with the entire teaching process. In the ORDER program, they own their teaching experience. This program is about empowering the graduate students as the expert, not as subservient to the research of others or the professors.

Furthermore, this program is a freshman seminar with about 16 students – not a chemistry class with over a hundred students. The idea behind the freshman seminar is to capture the students early. It presents the perfect opportunity for graduate students to share their discovery and be creative in that process.

What year are the graduate students?

All different years, but usually beyond the second year. If they have spent more time with their discovery, they are in a better position to teach, so this tends to bias our graduate students to those who are more advanced in their research process.

Do you see a disproportionate number of students from different areas?

Based on the need for funding. Yes, we do. At first, the call for applications was directed only at students in the natural sciences. Then, we decided to open up the program to grad students in the social sciences in response to the proposals submitted by the students taking the course. The call for applicants in March netted more students from the social sciences, possibly because they are looking for summer funding opportunities (many do not have funding from their own departments). The call for applicants in September netted fewer social sciences and many more natural science applicants. Overall, we have received a lot of applications from biologists and the basic sciences in the Medical School. In total, we have never been able to fund more than 10% of the applicants. Our results suggest an untapped resource is looking for opportunities to participate in the educational mission.

What type of students take the seminar?

Freshman who have never come to college before. Incoming students receive a packet in the mail in July that includes descriptions of the freshmen seminars. All freshman are required to take a freshmen seminar. So, those who register in the fall are choosing it based on a written description. When students are selecting courses in the spring, they often take the recommendations from their friends. We have many students in the spring who take the seminar because their friends took it in the fall and enjoyed the course.

How many students are in the seminar?

The freshman seminar is capped at 16.

Are there other sections of the freshman seminar being taught at the same time?

Yes, there are many – including one taught by our past president which involved taking the freshman to Ireland. But there have not been many options for students who are interested in science or the natural sciences. This seminar gives them an exposure to a broad diversity of science.

Why does Emory have a freshman seminar?

To create close relationships with faculty. This seminar doesn't really meet those needs. The students do form relationships with the graduate students, but not really with the faculty. I am involved with coaching the grad students, helping them figure out their curriculum, strategies to keep students engaged, how to plan field trips to their labs, etc. But, during the class sessions, it is the grad students who are in charge.

What is the concrete goal for the quarter itself?

The goal of this seminar was to answer the following questions: Is there a way to better position the freshman when they come in so that they have role models to go to in order to find out more about the resources at Emory? Is there a way to empower grad students and postdocs to be involved in UG education? Can we find ways to integrate these two things? This seminar does just that.

How are you evaluating this program?

We are administering pre-and post-surveys to the undergraduate students to find out how their perceptions of science have changed over the course of the semester. We also ask questions about whether they think their understanding of scientific concepts has improved, as well as their ability to present and understand scientific material. In addition, we are conducting interviews with the undergraduate students a year after they have completed the course to find out if it has influenced their current/future selection of courses, their understanding of scientific concepts in those courses, their future career plans, and their general perceptions of the big picture of science.

To evaluate the graduate students, we give them a survey when they begin their position, and again at the end of their term. Questions cover topics such as their background in teaching and research experience; their expectations from participating in the program; their feelings about collaborating with the other students; their role as a mentor for undergraduate students; and their future career goals and how they might be influenced by their participation in this program.

When you take the students to the lab – is that a great opportunity to expose the undergrads to the professors?

Yes, but the purpose is to empower the graduate students. So, although this might present an opportunity for the undergrads to meet the PIs, the idea is really to show them the graduate student's research. In fact, during one visit to the lab, the graduate student's PI was actually assisting her with one of the stations she set up for the students. Many of the undergraduate students go off and get research positions after visiting the labs.

One of the things that seem to be important – who in the university has power and is willing to share it? But grad students do not have power and the undergrads need to know that. Do they know this? How do you explain this?

Speaking as a faculty member, I know that my grad students and post docs hesitate to speak when I am there. They need a separate experience to feel like they can talk about their research. So, the idea is to have a space where graduate students are empowered.

So far, in the feedback we have received from the undergrad students, they understand the connections between the graduate students and their PIs. In fact, they leave with an understanding of even a bigger picture; they understand how students like themselves can enter research, go to grad school, find a PI, do their own research, and end up wherever they want, i.e., med school, grad student research, etc. in their own research positions, and how this can be applied to real life experiences (i.e. curing cancer).

But if the PIs feel like they are going to have to get involved, they are going to say no to the experiment. PIs have enough to do. If they feel like allowing their students to participate in this program means more work for them, then they won't allow their students to get involved. It is better if the grad students can do it without their PI.

How do you make sure that undergrads are feeling connected to a PI? It is really going to show them how the university works?

This is an easier way to get to the professors, through the graduate students.

Well, it seems like if the goal of the program. . . if the objective is to connect students and faculty - -who cares if they learn anything in the classroom? How frequently do your students come and talk to you? What percentage go out and get a research position? But did they learn course specifics? Who cares?

For those of us who do not have the funding – how low can I pay them?

Make something that doesn't exist in most graduate student settings; gain expertise. This makes them more qualified than other candidates. Give them the experience as credit, but not money.

Five out of ten of our teacher-scholars have gotten academic jobs. They have all used their teaching module from the seminar at their job talks and gotten jobs; they can talk about their teaching philosophy and they have tried and tested it. Graduate students need time to teach if they want to do it down the road.

Are they better are at writing their thesis? Are they better at presenting their research?

Students who are getting involved are further enough along not to get distracted from their own research. Many of them report that they actually feel better about their progress on their research because teaching for this program allows them to reconceptualize their project in order to explain it to undergraduates.

Do you think you are releasing the faculty from their responsibility of being mentors? The bigger institutional issue here is: How will the undergrads ever meet faculty?

This program is not to replace the basic courses and the relationships students have with faculty. This program does, however, allow students to learn about aspects of graduate school that they have never learned about before. Furthermore, this program is also for the graduate students, not as a replacement for PI and faculty.

How much time do the grad students spend during the semester on this program? How much time does it take away from their other responsibilities?

Each graduate student officially teaches for three weeks, but they mentor incoming students and they grade and evaluate all of the students' work, they meet throughout the months prior to plan curriculum. So, the workload varies. But, they work together to help one another out. If one teacher is particularly busy one week, the others will take on more responsibilities.

Do you give them any additional training before teaching?

They meet for the months prior to their teaching to talk about their modules, share teaching resources, share teaching philosophies and experiences. Some of them come in with teaching experiences to share with the group. These meetings allow them to come up with connections among all of their modules and find ways to teach interdisciplinary science. It is fun to watch and an added benefit to the program.

I would like to segue into talking about your own institutions: Do you see a way to empower graduate students in your own academic locations?

We have teams composed of different people – five teams around bioinformatics, biology, chemistry, etc. vertically integrated – looking across the curriculum, to investigate how are themes taught across the disciplines. Post docs and grad students are the drivers of program –and modules that can be plugged into different courses.

We have a class for post docs and grad students in which they learn about pedagogy. We create small groups and modules based on their own research, that they are able to teach in larger classes. They are able to take a semester and develop the units. We talk about things like: What are the processes to make a teachable unit? How do we assess the assignments? Upon completion, they end up with a certificate. It doesn't cost any money because they sign up for the program as a class. They deliver their module in the 200 plus lecture hall – (Michigan State).

We have to convince those who don't value teaching that this is important.

All of the freshman seminars at the University of Alabama are only one hour per week. Do you have any ideas about how to fit this kind of model into one hour a week?

Offer fewer modules. Combine the hour with a field trip.

I could imagine taking a class that I have right now and incorporating a module into my class. And have the grad students create and teach the module. For example, my grad student wanted to take time to teach elementary school students. I could mentor graduate students and have them as a TA for most of the semester, but they could take three weeks at the end of the semester and teach their module.

Recommendations

- The graduate students should be seen as a conduit to connect the undergraduates with faculty at the university.
- One method of translating ongoing research into the curriculum is to have the graduate students teach courses about their own discoveries.
- We need a new reward system for those who value teaching. We need to value graduate students' contribution to the institutional educational mission in addition to the research mission. We need to stop apologizing for having graduate student teachers.
- Train researchers to become educators – early in their careers! Give them the opportunity to hone their teaching skills as a graduate student.
- It seems like the participants at this conference all value graduate student teaching. This needs to be appreciated at the higher level of administration.
- We need to unstuff the curriculum. We keep adding facts, but we never take anything out of the curriculum. Let's revamp and figure out the key concepts that we want students to understand. We need to teach students about inquiry-based work rather than overloading then with memorizing facts.
- Teaching should not be optional for graduate students. We need to train our graduate students with some of the literature from educational studies so that they can figure out what they need to do to become better teachers.

Resources/References

Websites

1. The Summer Undergraduate Research Program at Emory (SURE): http://www.cse.emory.edu/sciencenet/undergrad/SURE/SURE.html
2. The "Origins of ORDER" (On Recent Discoveries by Emory Researchers) Freshman Seminar at Emory University: http://www.cse.emory.edu/sciencenet/coll_curr/order/index.html; For news releases about ORDER visit http://www.news.emory.edu/Releases/lynn1069363205.html and http://www.news.emory.edu/Releases/davidlynn1090849234.html

POWERPOINT PRESENTATION

www.sunysb.edu/Reinventioncenter/Conference_04/Lynn/Powerpoint.pdf

Breakout Session: Teaching and Learning in an Age of Technology: The Development of a Genetics Cognitive Tutor

Leader: Elizabeth W. Jones, Schwertz University Professor of Life Sciences, Head of Biological Sciences, and Howard Hughes Medical Institute Professor, Carnegie Mellon University
Recorder: Susan L. Pasin, Assistant to the Director, The Reinvention Center

This session was organized around the Genetics Cognitive Tutor (GCT), a computer-based teaching tool designed to promote problem-based teaching and learning of genetics. The session had two goals: 1) To educate participants about the cognitive tutor in genetics and the potential advantages it has over other methods of teaching genetics and 2) to explore the efficacy and merits of developing similar computer based tutors in teaching other subjects.

Presentation

Session leader Jones began by explaining the impetus for her involvement in the development of the GCT. First, in her experience, students do not like taking notes and prefer technology-based methods of learning; second, previous attempts to incorporate genetics software in her lessons have failed because of the lack of top quality computer-based teaching programs; and, finally, Dr. Jones felt that participating in this effort would provide a great opportunity for her to be part of a team of professionals that included experts from the Human-Computer Interaction Institute, other biologists at her own institution, Carnegie Mellon University (CMU), and biologists from several other institutions, including Harvard University and the National Science Foundation, who share her desire to change how genetics is taught.

The project team had several goals in creating the GCT. The primary goal was to speed the students' learning of genetics and improve their command of the subject. A second goal was to find a modality that is neutral in teaching students of diverse racial, ethnic, and socioeconomic status. Math cognitive tutors for middle and high school students, on which the GCT is based, have this capacity. A third goal was to improve the teaching of genetics nationally by disseminating the software widely

to colleges and universities and distributing simpler models to middle and high schools. A fourth goal was to eventually make the Cognitive Tutor commercially available.

The Cognitive Tutor has great potential to enhance student interest and involvement in a subject – and thereby improve learning – because it enables students to learn via a modality that to them is as natural as breathing, namely through computers. The approach it uses is to identify challenging problems and for each problem do a task analysis and develop a cognitive model, which is an expert system that mimics the ways students solve problems. Software is then written based on this model to support the students' learning. An advantage over less sophisticated genetics software is that errors are flagged "just-in-time" to provide help in the form of "hints" that allow students to succeed in solving complex, authentic problems. Students are required to answer each question correctly and show their work before they can proceed. The interfaces are designed to "make thinking visible." As the Cognitive Tutor accepts answers, the program interprets student behavior, and, when completed, will customize the lesson for the individual and predict how a student will perform on future exams. Studies have shown an average gain of 16 points, or 36% improvement, on exams among students who have used the Cognitive Tutor. The GCT program, which integrates principles of artificial intelligence, cognitive psychology, human computer interaction, and genetics, is based on earlier Cognitive Tutors used for teaching algebra, geometry, statistics, and computer programming.

Discussion

The discussion began with several questions about the advantages and disadvantages of the GCT: Has the non-biased nature of the program been tested? Is it possible to measure whether this approach alleviates misconceptions? Do problems exist with this program that mimic those encountered in tradition methods of teaching? What new problems does the GCT create? Can educational software effectively foster meta-cognitive skills and, if so, will students become better learners as a result? These are important issues that must be addressed, but, because the GCT is still in the testing phase, sufficient data has not yet been collected to provide the answers.

The discussion turned toward the challenges in creating a sophisticated computer-based learning tool. These include the various intellectual and administrative problems that accompany new developments, the need to test and demonstrate the efficacy and value of the tool, and the need for widespread dissemination. One major difficulty is the time and effort it takes to pull together a project of this magnitude and find professionals with appropriate experience willing to become involved. The extent of effort required of the disciplinary professionals, computer programmers and cognitive experts, as well as the cost of the materials necessary to develop the GCT, is enormous; it took, for example, two years to develop the eleven modules of the GCT that are currently being tested at colleges and universities across the country and is expected to cost $1,000,000 by the time it is completed.

Next, the session leader stressed the significance of the test institutions in creating superior and effective computer-based teaching tools and emphasized the importance of allowing the test groups enough time to incorporate the tutors into their lesson plans. Testing is carried out in two phases. The first phase consists of instructors in the test groups using the software for sufficient time to develop some expertise, involving enough students to determine merits and deficiencies and gauge the effectiveness of the software, and, following this, bringing the teachers who have used the Cognitive Tutors together with the disciplinary experts and the programmers to discuss software glitches and make suggestions for improving the program. The second phase involves refining the software based on the feedback and suggestions put forward. Testing can be expensive, particularly because the institutions testing the programs do not pay for the materials.

The final challenge is the difficulty in disseminating programs like the Cognitive Tutor widely. Broad dissemination is likely to occur only after the benefits of using the software have been documented. The Cognitive Tutor Algebra (CTA) course, for example, the most successful of the Tutor initiatives, is currently being used by 200,000 students in 1800 schools. Studies have shown remarkable gains by students in CTA classes in comparison to their counterparts in control classes, and the U.S. Department of Education has designated the CTA course as one of five exemplary curricula for K-12 mathematics education. The group agreed that the first step in acquiring the resources necessary to develop, test, and disseminate more computer-based programs is to test and document the benefits of the Cognitive Tutor programs that have already been developed and share this information with funding agencies.

Other computer-based teaching and learning programs are already widely available, but they do not offer the immediate feedback and the individualized active learning environments of the Cognitive Tutors. Examples of Web-based teaching and learning tools include the Multimedia Educational Resource for Learning and Online Teaching (MERLOT), a catalog of online, peer reviewed learning and teaching materials; and Dyann Schmidel's interactive educational Websites which provide a myriad of games, puzzles, and quizzes for all education levels in a variety of disciplines.

Recommendations

- Development of cognitive tutors requires a myriad of experts, including disciplinary and cognitive specialists and computer programmers. One suggestion was to bring these experts together in the hope that a joint effort would help increase resources and speed dissemination.
- The group expressed an interest in the development of web tutorial templates with essential characteristics that can readily be adapted to many disciplines. These templates could be valuable teaching tools that teachers can tailor the programs to their own classrooms.

Resources/References

Websites

1. The PACT Center Website: www.pact.cs.cmu.edu/ This site provides information about the Center's goals, completed and current research, biographies of the people involved, and links to sites with detailed explanations of these projects. The site also provides an extensive list of publications on tutor development and pedagogy research, cognitive tutor evaluation and implication, and other relevant PACT publications.
2. The Human-Computer Interaction Institute Website: www.hcii.cmu.edu. HCII is an interdisciplinary group of faculty and students at Carnegie Mellon University dedicated to research and education in topics related to computer technology in support of human activity and society. From the site's homepage, click the "research" link to find information about interesting research projects and computer-based learning tools.
3. The MERLOT Website: www.merlot.org
4. Dyann Schmidel's interactive educational Websites: http://schmidel.com/dyann.cfm

Breakout Session: The Changing Roles of the Humanities and Social Sciences

Leader: Reed Dasenbrock, Professor of English and Dean, College of Arts and Sciences, the University of New Mexico
Recorder: Naomi Frandsen, Graduate Student, Department of English, Georgetown University

Presentation

The humanities have long been using inquiry-based learning, small seminars, and a student-centered paradigm—all practices that have recently come into vogue in science disciplines as a way to build undergraduate research programs. Paradoxically, however, disciplines in the humanities have had difficulty in defining "undergraduate research" and in incorporating it as an element of the undergraduate education they offer. Session leader Dasenbrock proposed that undergraduate research be defined as the process whereby students, guided by a faculty mentor, engage in a structured experience that leads to the production of knowledge. The classical image of undergraduate research is of a student in a lab conducting an experiment or making a discovery that is eventually reported on at a conference or published in a journal. The willingness of scientists to work in teams toward collaborative knowledge production allows students to participate in the by-product of research. In contrast, humanities disciplines are committed to an isolated, faculty-driven system of knowledge production. This system of knowledge production in the humanities is currently at a crisis because university presses in recent years have increasingly been cutting back their publications, and faculty members seeking tenure no longer have the traditional outlets for their work. At this juncture, therefore, humanities disciplines are well positioned to rethink their definitions and modes of scholarship and to broaden them to include electronic scholarship, editing, and other activities built or potentially built around research teams. Finding ways to bring the teaching values into the realm of scholarship may contribute to this process of rethinking.

Discussion

Undergraduate research in the humanities and social sciences is important because students learn by doing, and research can push them beyond the level of simply producing a seminar paper. Undergraduate research also helps address information literacy, allows students to consume research more critically, and helps students define career goals by showing that there is a critical conversation in which they can participate. The forms of undergraduate research in the humanities should include elements of discovery, interpretation, and application, and typically culminate in an honors or senior thesis. However, since this individualistic form of knowledge production does not lend itself to collaborative research opportunities with faculty mentors, humanities disciplines should articulate levels of scholarly activities in which students can participate in preparation for producing their own original research. These activities—the labor of producing knowledge in the humanities—could include library searches, background research for a chapter, editing, and technology-based projects. Humanities departments should also look outside of themselves and identify other programs or sites that can assist in this effort. Learning communities, for example, that emphasize inquiry-based teaching and learning and can help educate students about how to generate research questions, how to critically consume resources, how to structure a presentation, and how to develop an intuition for the social relevance of a project. Although much of what faculty members and students do together has elements of research and in its totality may be viewed as research, it typically is not described as such. Unlike the sciences, the humanities have not yet developed a culture of self-description.

An important component of scholarship is the excitement and challenge that is inherent in the activity and the sense of fulfillment researchers experience when they solve a problem or make a discovery or put forward a new thesis. Having an in-depth experience which enables students to encounter the excitement and challenge of probing a subject and going to the next level helps them to develop a "research intuition." While students may study a subject and learn how to do sophisticated analysis of a work within the context of a class, interpreting and placing this knowledge in a larger social or intellectual context is more difficult and too often does not occur. Because this research intuition is at the heart of research in the humanities, students who do not develop it or who do not develop it until late in their college careers are at a disadvantage if they undertake a culminating research project in their senior year and/or in graduate school, if they choose to attend. Session participants briefly discussed how to encourage students to develop this research intuition. One approach is to have students do background literature reviews which can often provide a socially significant context for a subject or work that has been studied in class.

A major impediment to greater undergraduate participation in research in the humanities is students' lack of preparation. Many students do not declare majors until their junior years; thus they have only a short period of time to develop the necessary skills to engage in in-depth study of a subject. This lack of early training disadvantages students when they try to write a senior thesis the following year. Further, a faculty-mentored research project will often take longer than one semester, and if students do not have credit hours or time to commit to a long-term project, they lose the experience of seeing the research process through all of its stages. As one session participant noted, professors do not expect to write fully-researched articles within four years of being introduced to a topic. The current model of humanities research and knowledge production makes it difficult for students to gain a holistic sense of the process.

Another difficulty is finding a core of faculty who are interested in supervising undergraduate work. One problem is the time commitment it entails and the reluctance of many faculty to divert time from their own research for an activity that is not recognized nor valued by their peers. Another problem is the common perception that undergraduates are ill-equipped to engage in research. Many faculty do not want to engage in a conversation with inexperienced students who have not yet been critically trained. Although most of the session participants agreed that this was an unenlightened view and that students can always be valuable participants in a critical conversation, the problem of students' lack of in-depth background and knowledge of disciplinary discourse that would allow them to make discipline-wide assumptions and enter the conversation remains an obstacle.

Finally, the grade system creates an imbalance of power between professor and student which can also stymie genuine academic exchange. Students are often rewarded in their grades for simply absorbing and reproducing knowledge, or for being what participant called "sponges." Too often classes are not rewarding the skills and mental characteristics important for good, creative research. Although teachers should not discourage students from being diligent and working for high grades, since the current reward system does not measure students for "research" and "creative" attributes, students who might be most qualified for genuine research are often overlooked. Similarly, the current reward system does not encourage the development of research skills in grade-conscious students seeking to attend a highly selective graduate program where admission depends on a high GPA.

Faculty members can counteract some of these problems by (1) team teaching with librarians who can train students in responsible,

balanced research, (2) investing the time to actively mentor students and encourage and support their efforts to perform to high standards, (3) proposing research projects that include meaningful learning experiences for undergraduate assistants, (4) designing seminar papers/projects which require creativity and critical thinking, and (5) encouraging an attitude toward the learning process that builds critical thinking abilities.

Faculty members should be aware of not imposing certain methodologies or ideological projects on their students. One conference participant told of his son who does research at the National Archives, works in a genetics lab, and is in many ways a qualified, autonomous scholar. His mentor, however, wants him to do a certain type of historical research that does not reflect his own convictions or approach to scholarship. A poll of graduate students at one university found that while graduate students in the sciences conceived of themselves as working cooperatively with their faculty mentors, graduate students in the humanities often conceived of themselves in competition with their professors. By its nature, the humanities include ideological positions and conclusions, and mentoring should not require a student to conform to a professor's particular ideological biases. An art professor offered a related experience: As a professional and a faculty member, she has typically not allowed students to come into her personal studio because she is concerned that her own work will be both too influential and too intimidating for her students. Faculty can begin to think through problems of influence, personal bias, and mentoring by reconceptualizing the classroom as a place not to present subject matter to students every minute, but rather to talk about the production of knowledge in a collaborative setting. If, as undergraduates, students have experience working in a collaborative mode, when they become graduate students they may be less inclined to perpetuate agonistic models.

There are significant differences among humanities and social science disciplines in research models and approaches to undergraduate research. The social science have created feasible models for student involvement that often involve collaboration with faculty, graduate students and other undergraduates. The humanities, however, still structure scholarship as an isolated, individualistic, ivory-tower activity. Further, students need different sets of skills for different disciplines. In restructuring curriculum, administrators and professors should consider the exigencies of various skill sets and what will best prepare their students. Currently in the humanities, there needs to be a better articulated connection between learning communities, curriculum redesign, and research components. As the humanities seek to progress toward a more collaborative model, they could perhaps take lessons from the NSF, which requires that all of its grant proposals contain an educational element. Because the NEH is unlikely to establish this kind of discipline-wide precedent, the Reinvention Center and other institutions should consider ways of encouraging more collaborative models of knowledge production and academic work.

A key to undergraduate research is the establishment of a strong mentor relationship between an undergraduate and a faculty member. While such relationships are common in the sciences, there are few examples within the humanities. The University of Toronto has a small program in which undergraduates interact with senior professors from the first year on. In this program, second-year students compete for places on a research team designed by a professor, pursue a project in conjunction with the team focus, and, during their third year, can apply for an opportunity to take their own research abroad. Like many other programs, the University of Toronto program does not take GPA into account in the application process. This program creates a culture of research among undergraduates. When it was first started, the administration assigned the University's most senior scholars to work with first year students, to prepare them for participation in the program. Since then, the University culture has changed so drastically that freshmen, once conceived of as stereotypical beaker washers, are now being brought into research immediately, and sophomores are traveling to conferences and publishing papers. The level of their work has led to the formation of a new group of faculty members who are willing and eager to work with undergraduates.

Session participants recommended finding sites where intergenerational collaboration can take place among faculty, graduate students, and undergraduates. These kind of collaborative models are needed to counteract the agonistic model of competition that exists in the humanities. Sites might include native language preservations, museums, and cultural organizations. Projects could be community-based, akin to WPA-type projects, and involve local history or culture. Technology also creates new opportunities. Electronic publishing is about to undergo a remarkable revolution, and issues of intellectual property and the nature of knowledge production, for example, will stimulate changes in modes of scholarship and in the forms of dissemination. Electronic publishing might be a possible site for student-teacher collaboration.

On a related subject, as the university press publishing crisis continues, faculty members and professional societies will be required to redefine research, which may open possibilities for collaborative models. Professional societies can encourage this redefinition by reserving sections in their journals for collaborative work. They could also be encouraged to set aside issues or space in issues for articles in which undergraduates are co-authors. Many journals in the sciences have such set asides.

The discussion ended with a brief summary of several important themes: formal innovations that strengthen connections between the curriculum and undergraduate research programs; establishing a dissemination strategy similar to ones used in the sciences (i.e. the NSF education requirement and space allocated in journals for undergraduate publications); student collaboration with faculty members on their own research; and lastly, incorporating research-related activities in the curriculum so that students are able to develop the knowledge and skills to pursue meaningful research.

Recommendations

For Individual Campuses

- Core courses should be designed by interdisciplinary teams (including, for example, librarians) to build basic research skills and prepare students to do research at higher levels.
- Humanities departments should work to find sites where intergenerational collaboration among professors, graduate students, and undergraduates can take place. Such collaboration can be beneficial in counteracting the agonistic model of competition that often exists in the humanities. Some of these sites might include native language preservation, WPA-type projects of 1930s, and technology projects.

For The Reinvention Center

- The Reinvention Center should initiate discussions with professional societies about the nature of individualistic versus collaborative research in the humanities and social sciences. As the university press publishing crisis continues, faculty members and professional societies will be required to redefine research, which may open possibilities for collaborative models. Professional societies can encourage this redefinition by reserving sections for collaborative work.

- The Reinvention Center should compile a set of success stories for faculty members that show ways of engaging undergraduates in research activities.

Resources/References

Website

The Research Opportunities Program (299Y1) at the University of Toronto provides an opportunity for students in their second year in the Faculty of Arts and Science to work in the research project of a professor in return for course credit. http://www.artsandscience.utoronto.ca/current/rop/index.shtml

Plenary Session: Future Directions

Withholding the Academic Disciplines from Undergraduates

Speaker: Gerald Graff, Professor of English and Education, University of Illinois at Chicago

The argument of this talk is developed in my recent book, *Clueless in Academe: How Schooling Obscures the Life of the Mind*. In the book I discuss a number of different ways by which colleges '"withhold the academic disciplines from undergraduates" by failing to clarify the culture of ideas and arguments that, I claim, underlies these disciplines. At first sight, though, this version of my argument may seem self-evidently false. Whatever shortcomings undergraduate programs may have, failing at least to introduce students to the academic disciplines does not seem to be one of them. General education courses provide a rudimentary introduction to the disciplines, and then the various majors give a more intensive acculturation into them. And if the major in English, anthropology, chemistry, history, mathematics, or what you will does anything, it certainly exposes students to the practices and modes of thought of these disciplines, does it not?

In fact, I would answer no. The truth in my view is that what undergraduates are typically exposed to is the subject matter of the disciplines, not the disciplines themselves. Before you reply that this is a distinction without a difference, consider that in the humanities, for example, undergraduates study works of art and philosophy, but, except for a minority of graduate-school bound honors students, they are rarely expected to become familiar with critical and scholarly discussions of these works. As for the social and natural sciences, I defer to those closer to those fields than I am, but my impression is that the situation is similar to that in the humanities. That is, science and mathematics majors study problems in these fields, but are not generally expected to be familiar with the conversations of scientists and mathematicians, much less able to enter those conversations.

Now I would argue that it these critical and scholarly discussions that characterize the disciplines at any moment rather than the discipline's primary materials. If you study, say, *Heart of Darkness*, Plato's *Phaedrus*, an El Greco painting, or the American Civil War without some familiarity with the state of scholarly and critical discussions of these things, you may come away with an exciting and rewarding experience, but you will not have any sense of these works and events as objects of a discipline, something that means having a sense of the current state of discussion of them. For all you know, you may be viewing Plato or the Civil War the way they were seen in the nineteenth century, and that would no longer be the way disciplines now see them.

Indeed, exclusion from disciplinary conversations has virtually defined what undergraduate study means in the liberal arts tradition. That tradition has assumed the existence of a sphere of "liberal learning" that is independent of and separate from what professionals and specialists in the disciplines are concerned with and argue about. This sphere of liberal knowledge has been assumed to be what we want students to know as human beings and good citizens, not as technical specialists or vocational apprentices. And it has been thought that this sphere of liberal learning can only be compromised and denatured, if not corrupted, by the intrusion of disciplinary conversations. In the humanities, this thinking leads to the view that criticism and scholarship on works of art can only come between students and works of art themselves.

The problem is that that the sphere of liberal learning does not really exist apart from the way disciplines and other professions define it. That is, the conversations of literary critics and scholars about *Heart of Darkness* are themselves an important part of any serious contemporary understanding of the novel. Such an understanding of the novel would include, for example, the fact that, until recently, nobody saw anything very significant in the fact that Conrad uses Africa and black Africans as his image for the savage impulse that underlies the veneer of civilization and Enlightenment that Europe confidently takes for granted, but that in recent times this representation has become controversial, with some arguing that it smacks of ethnocentrism and racial bias. This understanding of the current state of the conversation about the novel, moreover, would today be expected of journalists as well as academics. Yet if I am right, this and other contemporary critical debates about the novel is only occasionally included in high school college courses.

But one reason why undergraduate research is so potentially transformative is precisely the challenge it makes to this long-standing way of defining liberal education as a sphere that stands apart from scholarly discussion and debate. The premise of undergraduate research, by definition, is that undergraduates can and should be part of the conversation of research scholars, and not merely as spectators but as participants with an active role in research themselves. In one way, this represents a stiff challenge to the traditional liberal arts tradition, but in another way it promises to reshape that tradition by redefining research as part of liberal education. Research in its turn figures to gain by being liberalized, which is to say that scholars may have to define their research less narrowly in order to teach it to undergraduates.

For undergraduate research to advance and grow, however, becoming something more than an option for a small number of honors students, entrenched practices rooted in traditional liberal arts thinking will need to be challenged. These practices are especially strongly entrenched in the humanities, in a way I want now to illustrate by referring to a course handout I recently came on that exemplifies a certain very standard approach to teaching the humanities. The handout was produced and circulated by the instructor of an introductory poetry course.

Since what I have to say about this handout will not be complimentary, I want to say at the outset that as a pedagogical strategy I think it is admirable in the frank, no-nonsense way it cuts through the clouds of mystery that generally surrounds the humanities and lets students in on the sort of thing they are supposed to say about a literary work. This question—what is one supposed to say about literature—is intensely mystifying and thus frightening to many students, yet typically we leave those students to figure it out on their own and punish them at grading time when they struggle to do so. In fact, it is the admirably explicit quality of these prescriptions that will make them vulnerable to my criticism. The problem is not in the fact that they are prescriptive, but in what they prescribe.

Take the comment that "Your goal is to make a convincing argument." This in itself is admirable and a great improvement over the kind of instruction which asks students merely to gather information and not only fails to ask them to make an argument of their own, but leaves them unaware that making arguments is one of the most important and distinctive things educated people do. The problem, however, is there is no suggestion that when students make an argument, they have to make that argument with anything or anyone. In fact, the model presented of what a thesis statement for an essay about a poem should look like makes it clear that the kind of argument you make in an academic essay is not an argument with, against, or for anybody else, but an argument in a vacuum, as if lost in space.

Here is the model statement:

> In "The Windhover," Gerard Manley Hopkins uses words with double meanings to express the apparent paradox that submission is more glorious than mastery.

What is immediately striking to me about this sentence is how far it is from anything any critic or any literate person would actually say. Not that one would never speak or write such a sentence, but it could never be an adequate thesis statement. It is not an adequate thesis statement because, as presented, it fails to give any indication of why it needs to be said in the first place. That is why such a statement leaves us wondering, does someone say otherwise? Could someone dispute the claim that Hopkins' double meanings express the paradox? Since no answers are suggested, the statement fails to answer the "so what" question: Okay, Hopkins uses double meanings to express the paradox. So what? Why are you telling me this?

In other words, as presented the statement is pointless, by which I mean nobody would ever think of saying it except in an academic assignment, where unfortunately we do not consider it unusual for statements to be made for no reason and without any point. Of course there is a kind of point--to let the students prove they have read the poem and can make an accurate and coherent statement about its qualities—but the underlying assumption here is that such artificial, make-work discourse is all we can expect from undergraduates, that they are not capable of entering the kinds of discussions that go on about literature in the real world.

In the real world, where we expect communication to have a point, we would not think of making such a statement about Hopkins double meanings unless we were provoked and motivated by something someone else had said or might say. That is why in the real world in order to give statements a point, writers and speakers present them as conversational responses to others. Which is why in the real world of research and criticism, statements about Hopkins's double meanings generally take the following forms:

> People who have discussed this poem seem not to have noticed that, in "The Windhover," Gerard Manley Hopkins uses words with double meanings to express the apparent paradox that submission is more glorious than mastery.
>
> Or
>
> Most readers will probably think that, in "The Windhover," Gerard Manley Hopkins uses words with double meanings to express the apparent paradox that submission is more glorious than mastery. Though such a paradox is what Hopkins does indeed seem to be doing, I want to suggest that the paradox is even more complicated than that.
>
> Or
>
> Critics have argued that, in "The Windhover," Gerard Manley Hopkins uses words with double meanings to express the apparent paradox that submission is more glorious than mastery. I agree, and would like to show how that paradox appears in other poems by Hopkins as well.

But notice that in order to write in this way you have to have some knowledge of the conversation about the poem and perhaps about poetry in general, or at least be able to imagine hypothetically how that conversation might go. If I am correct, however, it is this kind of conversation that undergraduates tend to be systematically screened from, and screened from it, moreover, in what is assumed to be the carrying out of the mission of liberal education, which is to focus on the great work (or historical event, or sociological or mathematical problem) and not on the scholarly or cultural conversation about the work.

We can now see that this type of assignment arises to meet a pressing need: It provides a way for students to make statements about literature and the arts when they are not part of the culture's conversation about those subjects. If you can talk about how certain double meanings express a paradoxical theme, then you can write an A paper in a humanities course without knowing anything about or being able to enter the conversation of scholars, critics, and general readers. To put the point another way, by talking about words and themes in a vacuum you can find things to say about literary and art works without resorting to Cliffs Notes. And it is no accident that the boilerplate statement about Hopkins' "Windhover" in the handout resembles very closely the kind and level of literary commentary that Cliffs Notes provides for students who do not master the art of making pointless statements in a vacuum.

To return to my opening remarks, then, I adduce the "Windhover" handout as a small but I hope not trivial example of how teaching and learning have been constricted and disfigured by a conception of liberal education that leads students to be exposed to the subject matter of the disciplines—in this case a poem by G. M. Hopkins—but not to the conversations about the poem that constitute the discipline and extend out into the wider cultural discourse about the arts. Students are asked to behave in ways nobody practices in the real world, making pointless statements in a void, in exercises that should properly offend anyone who expects his or her education to have meaning. Indeed, I am tempted to believe that many students would actually find the humanities less mystifying, and would accordingly take more humanities courses and actually fare better in them, if such exercises were replaced by ones that asked students to enter some part of the scholarly conversation. Such a shift would have the salutary effect of forcing us as educators to identify those conversations that are most worthy of being presented to students and to make them clearer and more accessible than they have been.

Making Critical Connections in the Social and Behavioral Sciences

Speaker: Bernadette Gray-Little, Professor of Psychology and Dean, College of Arts and Sciences, University of North Carolina at Chapel Hill

Comments

As I have read the papers, listened to presentations, and engaged conference participants in conversation, three loosely related items come to mind as important:

I. The psychology/sociology of conference participants
II. "Making critical connections" in social and behavioral science
III. Understanding self in context

I. The Psychology/Sociology of Conference Participants

Although I have limited experience of being a member of the majority,

I feel that in the place where I work, University of North Carolina at Chapel Hill, I participate in the majority political, social and intellectual climate. In such a context I have noticed that self-deception can occur about how common one's views are. So, for example, I know many people who were shocked by the outcome of the recent senatorial and presidential races since everyone they knew was voting for the candidates who lost.

Those of us who are here and advocating the involvement of undergraduates in research and the commitment of our faculty to this goal may be in danger—in danger of being affirmed by an unrepresentative group. Most of the presenters here speak with one voice about the importance of integrating education and research, about the valuable contribution of faculty members who do this. I experience, feel affirmation. I agree with most things said. Indeed, I have thought or said them myself -- although less eloquently. But, is this really the tenor of our campuses? Are we hiring faculty members who have this point of view? Are we rewarding and promoting faculty members who spend their time this way? Are we practicing what we are preaching here? Do we have the most experienced faculty teaching the least experienced students?

This is not an explicit topic of the conference, but I think it is important to note it and for us to try to create the environment in which the goals outlined here a re-pursued and rewarded.

II. Making Critical Connections in the Social and Behavioral Sciences

The theme of connection that we have happily expressed here is consonant with a theme we selected at Chapel Hill for our campus planning: Making critical connections. We have chosen to look at making critical connections in three ways:

A. Across the curriculum: Encouraging students to enroll in a cluster of courses in different disciplines, but with interrelated themes, e.g. courses in history, philosophy, literature of the same period; courses in psychology, biology and philosophy addressing the mind-body debate. We expect these connections will foster a deeper and more sophisticated understanding of complex questions.

B. Internationalization: As a means to facilitate understanding of other cultures and nations and to help us perceive our own society in context.

C. Research: Making critical connection from the classroom to the field, laboratory, whether in the natural sciences, social and behavioral sciences, humanities, arts or professional areas. I want to underscore Dr. McDaniel's emphasis on "elaboration," not mere repetition, as an important component of learning, understanding and memory. It seems to me that research (and its application) can be seen as the ultimate form of elaboration and thus a prized way of learning.

In the social and behavioral sciences, almost every topic is interdisciplinary; most can only be comprehended by cutting across fields of study. In the social and behavioral sciences, most topics are international or address issues (group conflict, political systems) that are universal. Thus making critical connections is an ideal theme for social and behavioral science researchers to emphasis with undergraduates. Among the many topics that students might examine, I will mention three:

(1) Internationalization. Increasing globalization will make it more important to study the interrelations among cultures (e.g., the "clash of civilizations"), political systems, societal institutions, etc. (International terrorism would fit nicely under this general topic.)

The social and behavioral sciences are uniquely positioned to investigate these kinds of issues since they study how societies work, how cultures and groups shape behavior, and how people are affected by their social, economic and political contexts.

Examples of Undergraduate Research Projects:

--Study how people from different cultures interact with one other in the local community (e.g. in stores, churches, and schools).

--Examine how and why a single company such as Wal-Mart is involved in many countries. What are the advantages for Wal-Mart? What are the consequences for people in the various countries? Who suffers economically and socially from the existence of a company like Wal-Mart and who benefits?

(2) Social and behavioral aspects of biology. It will become increasingly clear that biological processes have important social and behavioral causes and consequences. At the same time, behavior has many biological consequences. The dividing line between the "social" and the "biological" will also become less clear with regard to a number of important issues, e.g. the extent to which aggression is a sociological and psychological, as compared with biological, phenomenon.

International terrorism is a topic that illustrates the connection between individual behavioral phenomena (aggression) and the importance of an international context. Is aggression best understood as individually, sociologically; or culturally determined? Does it make sense to talk about the biological basis for terrorism in the same way that we study biological contributions to aggressive behavior?

Although it is more difficult to involve undergraduates directly in the study of international terrorism, there are proximate examples involving the United States to which faculty members and students might again access. In an article on "How Social Science can Reduce Terrorism" (*Chronicle of Higher Education*, 9/10/2004), Plous and Zimbardo suggest that reducing intergroup conflict, creating incentives to reduce terrorism, and socializing the young to reject violence as means of problem solving are all important interventions and avenues for additional research.

(3) Polarization. There has been a growing polarization in the United States along a number of different dimensions. This polarization is reflected in the greater inequality that now exists among groups with regard to phenomena such as voting behavior, earnings and wealth, work effort, and health. Such high levels of inequality which are often symptoms of people being treated unfairly, represent challenges for societies.

Examples of Undergraduate Research Projects:

--Study how one's class position (defined by type of job, income level, where one lives) affects ones' political party affiliation and choice of candidate for whom to vote.

--Study the nature and consequences of racial composition of poor vs. rich people in the same city.

III. Understanding Self in Context. Studying the Nature and Consequence of Racial Composition

This brings to mind my third point: It is important that students of social and behavioral sciences learn to understand self in context.

Professor Gardner asserted that he has come to believe that character is more important than intellect. I am tempted to subscribe to that view—which would mean that in the final analysis my mother was correct. I want to expand here on one feature that I think is important to the development of character: self-knowledge and knowledge of self in context. I'll use the example of a student who traveled to Eastern Europe to conduct a study on the role and status of the Roma in the local society to make my point. The student read about the Roma people, interviewed many, and also interviewed educators and politicians. She learned that the Roma had been treated like outcasts, subject to legal exclusion; their children received inferior education; they were relegated to certain geographical locations; were not fully integrated into society. She was indignant that in modern European society a group of people could be so severely mistreated. When she presented her work at a research symposium, her comments indicated not only indignation, but also her sense that she had never seen or been a part of anything like this before. As she expressed her indignation, all of the adults in the audience began to exchange glances with one another, thinking is it possible that this well meaning student did not see parallels between the experiences of the Roma and a number of groups in American society. It turns out that she did not. It became apparent that the student perceived the Roma situation as foreign, unlike anything she had observed or as a member of the majority in US society experienced. She did not recognize the parallels to the experience of several minority groups in the United States.

The comments and questions in reaction to her presentation helped to close the circle for her. I believe some of her best learning came from her presentation and the feedback she received, which compelled her to probe her own work.

Obviously, character is more than understanding self in relation to others, but it is critically important for our students that they understand who they are, to what groups they belong, how groups interact with one another, how groups resolve conflicts without conquering one another.

This is the important contribution that social and behavioral sciences can make to the advancement of knowledge and improvement of society.

Changing the Way We Teach Science

Speaker: William Wood, Distinguished Professor of Molecular, Cellular, and Developmental Biology, University of Colorado at Boulder

As we wrap up this conference, I would like to talk briefly about what we can do when we go home to address what I see as a major impediment to changing research universities in the way that we would like. I am referring to the general lack of awareness among university science faculty and administrators that the present system is not working, that it is important to fix it, and that there are practical ways to go about doing so.

As Carl Wieman documented clearly on the first day, we are not doing a good job at teaching undergraduates, at least in our introductory and non-majors science courses. Students are still coming away with the view that science is primarily a collection of facts, and we are generally failing to help them progress from thinking as novices to thinking as experts. In these large courses, we do not engage our students actively; rather, we lecture to them. I liked the phrase that Nancy Cantor used to describe the ideal classroom as "an experience-oriented imaginative space." Does that describe the typical science lecture for beginning students? I don't think so – certainly not my own classes over the years, although they are now moving toward that ideal.

Probably all of us here would agree with the premise of the Boyer Commission report (1998), that research universities, with their well equipped laboratory facilities, their human resources of graduate students and post-doctoral associates, and their research-active faculty, have unique potential for educating undergraduates. But we would also agree about the need to change and improve current practices in order to reach that potential. In the breakout session I participated in yesterday, someone pointed out that change is likely to come only when and if there is widespread dissatisfaction with the present system. Unfortunately, this dissatisfaction does not exist among most of the faculty at our research universities, who regard their teaching as adequate given the constraints on their time and the large numbers of biology majors they must deal with. I submit that we must sow some seeds of dissatisfaction! We must raise faculty awareness of:

1) The results of recent research on learning, the evidence for inefficacy of current approaches, and the importance of improving on the current standard lecture course format.
2) Successful alternative teaching models in their disciplines.

We heard about the startling results from recent research in cognitive and educational psychology at the second plenary session yesterday. Why have most of us not seen these results before: convincing data showing that many of our own and students' perceptions of how best to learn new material are wrong? Carl Wieman presented some of the evidence from physicists (and there is much more: see for example Hake, 1998; Saal et al, 2000) that active engagement courses produce substantially higher normalized learning gains for students than do standard lecture courses. In other disciplines, we need validated tests for measuring conceptual learning gains such as those developed by the physicists, and we need examples of comparisons between standard and active-engagement courses. The physicists have shown clearly that the standard lecture format produces relatively poor results; presumably the same is true in other disciplines.

Regarding alternative teaching models, many faculty assume that the only practical way to teach a large course is through lectures, and that interactive engagement in class and individual attention from the teaching staff are impossible in classes larger than around 30 students. Carl Wieman, Eric Mazur and others in physics have shown that these assumptions are not true if current information technologies are exploited. Personal response systems ("clickers") allow for active give- and-take between instructor and students in a large class (Wood, 2004). With clickers, student responses, for example to a multiple choice question posed by the instructor, are anonymous during the class, so that individuals are not afraid of giving what might be a "dumb" answer; however, the system records the responses of individual students if desired for record keeping. After students have voted on a question, the system displays the percentages of students who chose each answer. Immediately, the students see how their responses compared to those of the class as a whole, and, most important, the instructor obtains instant feedback on what fraction of the students are not understanding the topic at hand, and can do something about it on the spot. If only about half the class gets the right answer, the best thing to do may be to ask students to talk with their neighbors and try to convince one another about who is correct. After a few minutes of discussion, if a re-vote is taken, most of the students will choose correctly. This process is what Eric Mazur has called "peer instruction" (Mazur, 1996). It almost always works. Moreover, the students in such a classroom are not sitting passively taking notes, but are actively engaged in trying to solve a problem—a prerequisite to meaningful learning as we have heard at this conference. Again, we need to publicize examples of how such approaches work in other disciplines besides physics, to help persuade our colleagues to give them a try.

I am involved in two initiatives to help raise awareness about these issues, and I would like to mention them in hopes that others of you may wish to participate as well. One is a relatively new online educational journal called *Cell Biology Education* (http://www.cellbioed.org). Despite its title, CBE is becoming a general journal of education for the life sciences. It is sponsored by the American Society for Cell Biology, and it is a good example of the important role that professional societies can play in raising awareness about the need for and the means toward reforms in undergraduate science education. Rather than being written by and for educators, like professional education journals, CBE is written by and for practicing life scientists like many of us here at this meeting, who are participating in educational innovations and reforms. This journal is relevant to a good question asked yesterday on the science of learning: "How can we learn about these kinds of results from educational circles? We don't see the education journals in which this research is published, and even if we did, we wouldn't be able to understand the jargon well enough to read them." One answer is journals like CBE, of which there are now several in various disciplines. You will be able to read and understand it, and I hope that some of you may wish to contribute of articles to it in the future.

A second initiative I am involved with is the National Academies Summer Institutes in Undergraduate Education in Biology (http://academiessummerinstitute.org). Created in response to the recent National Research Council (NRC) report Bio 2010 (2003), the Institutes are designed on the principle of the well-known Cold Spring Harbor Research Courses: Bring as instructors a few dedicated researchers in some ground-breaking area of biology together with a group of highly motivated student- and faculty-level trainees who want to learn about this topic, and spend several intensive days in presentations, discussions, and hands-on laboratory research projects. The first Institute, sponsored by the NRC and the Howard Hughes Medical Institute (HHMI), was held in summer 2003 as a pilot (in that almost all the participants were faculty members and educators already involved in teaching innovation and reform), to see if such a meeting could be engaging and worthwhile (Wood and Gentile, 2003; Wood and Gentile, 2003a). The participants judged it a spectacular success, several writing that it was as exciting as any scientific meeting they had ever attended. A second Institute was held in August 2004, again funded largely by HHMI with help from the National Academies. The facilitators were again biology educators and faculty teaching innovators (several of them graduates of the pilot Institute), and the "students" were chosen from a pool of about 35 applicant teams. The teams consisted of two or three instructors from the same institution, including at least one junior and one senior faculty member involved in introductory biology teaching. Preference in admission was given to teams from large research universities, where the organizers felt teaching problems at the introductory level are generally most acute. Teams from 19 institutions were invited to attend. The Institute again involved four days of intensive presentations, workshops, and discussions on several problem areas in teaching large introductory undergraduate courses. As part of the program of hands-on activities, each team worked to develop a one-week "teachable unit" featuring active student engagement, which was demonstrated at the end of the meeting and made available for use by others in their courses during the 2004-2005 academic year. Each team was sent home with a small stipend for facilitating educational improvements at their universities, in their own courses and those of their colleagues. Again, the students rated their experience at the Institute as tremendously valuable (Wood and Handelsman, 2004).

Although only 39 faculty were present as students, we estimated that they would be teaching more than 20,000 undergraduates during the coming year. We anticipate that the Institute, which plans to continue with one or two workshops annually, will have a ripple effect, helping to spread better teaching practices among life scientists in university communities across the country. Staff at the National Academies and the NRC are hopeful that similar Institutes can be established in chemistry, physics, and other disciplines.

So what can each of us do when we return home, to help spread the lessons we have learned at this conference to our colleagues? First, we can learn more ourselves about research on and practice of effective teaching approaches. A good place to start, with many useful resources listed in an online supplement, is a recent *Science* article entitled "Scientific Teaching" by Handelsman et al. (2004). Then we can start working on our colleagues! Below are a few suggestions for "subversive" action.

- Change is threatening to many faculty. Don't scare them! Present teaching reform as an incremental process, not a revolution. Lecture courses do not have to be reworked all at once; they can evolve in small steps toward incorporating more active-engagement activities.
- Clickers: Let faculty colleagues experience use of a Personal Response System (clickers) and encourage them to adopt clickers for their teaching. They are a catalyst for change; anyone who uses them at all intelligently will not be able to ignore the evidence that many students are not learning much in their lectures. Small portable wireless receivers are now available that can handle a class of up to 1,000 students for as little as $350.
- Find out if there are reform-minded colleagues in other departments, and partner with them on interdisciplinary educational initiatives. They will be especially helpful if they also have strong research reputations.
- Bring outside speakers on pedagogy into the departmental seminar program to introduce examples of transformed courses and how to assess their effectiveness.
- Start an in-house pedagogy discussion group that includes faculty if possible, also postdocs and graduate students, and undergraduates as well. Many young faculty and future faculty are eager to learn more about teaching, what works and what does not.
- If your university has a School of Education, invite some of its faculty to your department to inform you and your colleagues, consult, or collaborate in new course development and assessment.
- Encourage your colleagues to participate in the growing number of education sessions at meetings of their professional societies. Encourage societies in which you are a member to improve and give more visibility to these sessions.
- Administrators, you have the most power to bring about changes! Reward faculty who develop innovative and successful inquiry-based courses, not just those who receive good student evaluations. As presently used, student evaluations are an institutional impediment to applying effective learning strategies! Reward faculty for appropriately assessing conceptual learning in their courses, and for publishing the results of their teaching reforms in respected educational journals like CBE.

Clearly, there is considerable inertia among university faculty, but these are some small ways to begin overcoming it. Let's go home and try them!

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Summary Remarks

Speaker: Judith A. Ramaley, Assistant Director, Education and Human Resources, National Science Foundation, and President Designate, Winona State University

Core questions: How can we introduce our students to more sophisticated thinking and responsible action through the design of the undergraduate experience? What should we expect of a college graduate?

Underlying Questions:

a. Is there anything really different about the undergraduate experience at a major research university for most undergraduates? Can the research environment and its assets be made a more integral component of the experience of all students? If so, is this a good idea and how might we accomplish this?

b. What do recent studies and reports about the requirements of the 21st century workforce tell us about how we should educate our students and what they should know and be able to do when they graduate? What is timeless about a good education and what is acutely timely? How much do we need to change our expectations, our goals, the design of our curriculum and the way we assess students? How does a research mindset fit into the portraits being provided of an educated person for the 21st century?

c. Do our current courses introduce students to disciplines or only to the products (i.e. abstracted subject matter) of a discipline? Do students get to talk about ideas or do they just hear about them? Can you really learn something without talking about it and exploring it, without knowing where the material came from and how it has been shown to be valid? Must we always speak in the privileged discourse of a field (thus bewildering our students) or can we use plain and simple talk for complex and subtle ideas? Is something more real to us if the answer is NOT in the back of the book or if it does not turn out the way we expected it to? (Lovely questions posed by Gerald Graff in *Clueless in Academia: How Schooling Obscures the Life of the Mind.)*

d. How will the recent work of the Reinvention Center and scholars of teaching and learning help us in answering questions like this?

The preset answer to the first set of questions invoked in this conference is "by engaging them in a research-based education." What does that mean? The integration of research and education can be thought about in at least five ways.

1. Whenever we invest in research capacity and contribute original work to a field, we are creating an educational asset. This asset can be deployed in a number of ways: To provide research experiences for undergraduate students, high school students and high school and middle school teachers and to promote public understanding of science, research and technology. In some instances, the research activities themselves can be designed in such a way that the general public can also contribute to the work, through gathering of observations and data.
2. The results of research on cognition, learning and development can be incorporated into educational practice to promote more effective approaches to teaching and learning. This can be most effectively accomplished when researchers and practitioners work together to define problems of special importance, gather data and interpret those data. This process of collaborative research also facilitates the application of research findings to practice while making it possible for the realities of practice to challenge theory and define research goals. One necessary condition for the integration of knowledge about learning into education is the attitude of faculty and teachers toward the integration of research and education itself. Researchers must take education seriously, and educators must take research seriously.
3. The emerging pattern of work on teaching and learning is acquiring the qualities of any scholarly contribution, hence the label "the scholarship of teaching and learning." It derives its inspiration in part from concepts of the scholar practitioner who attends to the realities of his or her practice and seeks to advance the profession, in this case, the professional obligations of an educator (Donald Schon), and in part from the application of the ideas and methods of various disciplines to the study of the undergraduate experience and learning, both in the context of the disciplines and in the larger interdisciplinary and integrative context of general education.
4. In some instances, research can be incorporated into the design of educational experiences for all students, not just those who can be accommodated on a research team or in a field or laboratory research project. This can be done through such pedagogies as service-learning, inquiry-based learning and project-based learning.
5. In all cases, a scholarly mindset appropriate to a particular field and an approach that promotes an exploration of the ideas and tools of different scholarly perspectives can be introduced into the classroom so that students learn in a mode comparable to that employed by an investigator, even if the work they are doing is not an original contribution to the literature or knowledge base of the field. It is possible to explore the mindset and habits of a researcher and scholar without doing original work.

We can envision a pattern of inquiry across the stages of an undergraduate experience in which the complexity and challenge of the intellectual work rises steadily while the potential impact of the work on others expands as well. I have called this The Dewey Line, a line drawn at a roughly 45 degree angle on a graph of increasing intellectual challenge and scholarly authenticity on the Y-axis and increasing value and complexity of the problem to be addressed and the potential societal impact on the X-axis.

How can research be introduced into the curriculum?

The curricular support for the development of a scholarly mindset can come from the design of courses that explore how people think and work in the context of a particular discipline. Appropriate augmentation of individual experience through the development of learning communities put together to resemble a scholarly community can reinforce the impact of individual courses or groups of courses.

A gradient of experience can be reflected in the nature of the research experience over the different phases of the undergraduate experience. At the freshman or sophomore level, a student may be immersed in a research group. In the sciences, for example, a student may be learning techniques and performing measurements or preparing equipment under the supervision of more experienced undergraduate students, graduate students or postdoctoral fellows. At this stage, the student is absorbing a research/scholarly mindset and learning some basic research skills, but is working on someone else's problem.

At the next level, students may be given the opportunity to experience "real" research as a member of a laboratory group. This may be summarized and expanded through a variety of capstone experiences or senior thesis options that introduce students to the rigors of authentic scholarship where the problem is their own and the work is their own.

Why is it important to provide research experiences?

There are many reasons to introduce students to research experiences, either as part of a course or as an adjunct to the curriculum. Among the reasons overheard at this conference were:

a. To identify and encourage future scholars
b. To provide a successful transition from early phases of education to a more demanding level of advanced study where students take increasing responsibility for their own educational agenda and progress
c. To explore career options (i.e. Do I like doing research?)
d. To learn what research can and cannot provide and how to use the results of research and apply them to practical problems and professional practice
e. To learn that knowledge is not static and that it expands endlessly
f. To learn how to handle competing claims and to realize that there are no perfect answers to vitally important questions
g. To set in place the opportunity for students and instructors to work together differently and benefit from one another's expertise and interests—to reap the benefit of interactions with scholars who are creating new knowledge, defining a field, contributing the work that will be in the textbooks and journals a couple of years from now and to begin to see into the discipline of a scholarly mind (to welcome students to Burke's Parlor)
h. To open up the mysterious process of where ideas come from and how an active mind works and what it means to explore ideas through the lenses of particular disciplines or in the integrative context of many disciplines
i. To build a good resume

Some attention was given to the challenge of moving students from the position of novice (absorbing other people's ideas and learning to discern the complexity of things) to the portfolio of an expert (challenging, questioning and contributing new ideas). Being good at absorbing other people's ideas is not a predictor for being good at doing original work. A failure to figure out the difference between the two (i.e. absorption vs. original thinking) has led many a student to get stuck at the advanced level and fail to complete a degree because the qualities that predict success at an advanced level are different from what ensures success at the undergraduate level for most students.

What challenges face our research universities today as they seek to embrace their responsibilities for providing exemplary undergraduate education? Unanswered questions that underlie much of what was discussed at the conference.

- In what ways is a major research university different culturally and intellectually from other postsecondary institutions, and what role can and should our research community play in advancing undergraduate education and in exploring how best to integrate research and education?
- How does the research university itself learn and from whom? What are its broader responsibilities as the source of most of the nation's higher education faculty? How should we prepare our graduate students and postdoctoral fellows, many of whom will not seek to pursue a career in a research university or even in the Academy?
- Why do we want to place research at the heart of the undergraduate experience and what will that mean in practice? Not only do our institutions have limited capacity to engage students in the scholarly work of faculty (usually 10% or less of students do original work of this kind), but many students lack an interest or an inclination to do so. What do we want our students to learn from their research experiences and what are some alternative ways to accomplish those goals that match up better with disciplinary differences (many mathematicians, humanities and arts faculty work alone and would have trouble finding appropriate opportunities for students) as well as with student career interests. How about business majors, social work majors, engineers who must engage in the work of the scholar practitioner but will probably be disinclined to do "basic research."
- Might we consider replacing the word "research" with the more expansive term "scholarship" as Ernest Boyer used it, allowing students to experience discovery, integration, interpretation and application of knowledge throughout their undergraduate years?

Summing Up

Wendy Katkin

This conference on "Integrating Research into Undergraduate Education: The Value Added" was the second major conference sponsored by the Reinvention Center. The program was planned with several goals in mind. First and foremost was to take up the two main challenges that were posed at the conclusion of the first Reinvention Center conference (November, 2002) and that have dominated discussion at the Center's regional network meetings. The first is the intractability of the academic culture at research universities, which continues to emphasize research productivity and graduate training, often to the detriment of undergraduate education. The second challenge is helping faculty and administrators to understand the unique undergraduate educational experience that research universities can offer, given their singular assets, and bringing this understanding to their own teaching. How can universities integrate their dual missions of "knowledge creation" and "knowledge transmission" in order to enrich and give new meaning to

their undergraduate programs? How can faculty infuse the frame of mind that drives their research and graduate programs into their undergraduate teaching? While many faculty members report that they can envision doing this on a one-to-one basis or in a small seminar, they are stymied when confronted with large classes made up of students with diverse interests and backgrounds.

Recent advances in the "science of learning" which yield understanding of how people process information, think, and remember can help them to improve teaching and learning for all students. A third conference goal therefore was to familiarize conference participants with the substantial literature on learning that now exists and with ways in which principles of learning can be adapted to address different educational settings and disciplinary styles and the needs of diverse populations.

A final focus of the conference was to look to the future and contemplate major forces that will be re-shaping research universities. These include the rapidly changing state of knowledge, the increasing "fluidity" of disciplines, new technologies that create new opportunities, and new undergraduate populations.

The conference clearly demonstrated the increased attention that universities have given to undergraduate education in the past two years and the considerable progress that has been made, particularly in expanding research opportunities for all undergraduates, revising individual courses and the overall curriculum in order to bring inquiry-based learning and "research-related" skills to the fore, creating first-year experiences that give students an early exposure to research and research processes, and providing mechanisms for faculty professional development.

Nonetheless, despite this activity, participants at virtually every conference session noted that the culture at their universities still does not value fully efforts directed at undergraduate education. Furthermore, there was remarkable consensus on what needs to be done to bring about a genuine re-ordering of priorities. The most penetrating and persistent challenges are listed below, along with possible ways to address them. These challenges were identified at almost all conference sessions and highlighted in the "recommendation" list each group was asked to put forward, and they emerged also in the comments participants made on the Conference Assessment Forms. The Reinvention Center will use this list as a basis for establishing its priorities and planning its activities in the next two-to-three years.

Academic Challenges

Defining Undergraduate Research

Research universities now widely accept the Boyer Commission's recommendation to make research and creative endeavor a central component of their undergraduate education. This acceptance is evidenced in the multitude of programs with a research focus that have been established on university campuses and in the extensive curricular revisions that have taken place, mostly with the goals of introducing, engaging, and preparing students to do research and creating new and more varied venues in which they may do it. Yet, as was made clear at the conference, in their efforts to provide a research-based undergraduate experience to large numbers of students, university faculty and administrators still face myriad challenges.

The primary recommendation, made at more than half the conference sessions, is for the Reinvention Center to take the lead and work with its constituents to develop a definition of "undergraduate research" that individual campuses can use to guide their own definitions and standards. This will require achieving collective understanding of what we mean by "undergraduate research," and of what are the perquisite activities and processes of a meaningful research experience. The definition should also indicate the essential elements and parameters of such an experience. In making this recommendation, participants echoed the sentiments of colleagues who had attended the previous Reinvention Center conference: "The definition of 'undergraduate education' remains a problem; continue discussion of how we, research universities, define "research;" define the goals for students and for faculty of undergraduate participation in research . . . . "Can students derive similar benefits from other inquiry-based and creative experiences?" (*Proceedings*, 2002, pp. 90-91).

Conference participants agreed that any definition that is developed be inclusive and applicable to a broad spectrum of scholarly and creative work, and allow for a wide range of experiences for students at different levels. It should also clarify some of the complex issues surrounding "research" and experiences that have elements of research. Some of the most salient are:

- Distinguishing between "genuine" research and research-related experiences, such as problem-based learning and hands-on activities. Distinguishing between research as a part of general education, leading to the development of an educated citizen and research leading to development as a future professional within a discipline.
- Defining the various genres and parameters of public scholarship, service, internships and other non-traditional approaches.
- Defining the undergraduate research process within different disciplines and the elements/activities that comprise a meaningful research experience.
- Determining reasonable goals and responsibilities for faculty and graduate students who supervise undergraduates?

Achieving consensus on what is undergraduate education and on its key elements will help individual campuses as they evolve their own definitions. At the same, there are several key issues that campuses will need to address locally:

- Ensuring that the campus definition, requirements, and goals for undergraduate research are transmitted widely to faculty and students so that both groups have a common understanding of what is expected and the research experience is congruent with this understanding.
- Developing criteria for measuring students' overall performance and skills development.
- Building in mechanisms to follow up on the experience and gain understanding of how it fits into the student's overall education. How, for example, does involvement in research influence students' performance in their classes? What constitutes good/valuable reflection? What is the long-term impact of a research experience?
- Developing realistic expectations among faculty of what undergraduates can contribute to a research or creative project, and, similarly, giving students a realistic sense of what research is and what they will be doing and will be expected to do.

Promoting and Expanding Undergraduate Participation in Research

As demonstrated at the first Reinvention Center conference, increasing student participation in research remains a major priority at universities, as do other related issues such as how to accommodate the large numbers of students that research universities serve; which groups within the undergraduate population to target; how to prepare and motivate students of varied backgrounds; how to provide equal opportunities to students, regardless of major; and how to expand the pool of faculty

supervisors, particularly in the humanities, lettered social sciences and arts. Though these issues were raised at almost every conference session and continue to be of major concern, the extent to which universities appear to have acted upon them is noteworthy.

The actions fall roughly into three categories:

Identifying New Venues and Linking them to Academic Programs

In recent years, there has been a convergence of two trends at universities. One is to identify new and more varied venues for student research. The other has been to broaden the scope of undergraduate education to include social responsibility and public citizenship. There has been a proliferation of innovative courses and academic programs that have public scholarship, service learning, and community-based research as a key element. These programs are often attractive to students who either are not oriented toward traditional research or scholarship or choose not to pursue such activity, or who are majoring in disciplines in which undergraduate research is rare. In conjunction with these programs, campuses are increasingly looking outward to the local community and even to international settings as resources and sites for undergraduate scholarly activity. Further, "service" in many instances is being reevaluated to include specific projects requiring in-depth study. The effort to develop multiple outlets for research and to incorporate research into academic programs has not only increased universities' capacity to offer more students a research experience, but it enables them to reach a wider swath of students, and it has broadened and enriched their undergraduate offerings.

While many of the beneficiaries of these new programs have been undergraduates in the humanities, lettered social sciences and the arts, participation in scholarly activity by students in these majors still is significantly lower than that of students in laboratory sciences. Several strategies for increasing participation were put forward:

- Create new curricular and research models to encourage and prepare students to do scholarly activity.
- Initiate team projects and intergenerational collaboration among professors, graduate students, and undergraduates.
- Take advantage of advances in technology.
- Create strategies that expose students to the arts and incorporate cultural practice into our teaching.
- Create or charge a central office to work with humanities and arts departments to organize and provide support for campus-wide events that showcase their students' accomplishments.

Curricular Reform

Campuses have been re- examining their general education and major requirements with an eye toward linking the two and structuring the undergraduate curriculum so that students have a progression of experiences, beginning with an early exposure to research and "research-like" activities in the first year and leading to a capstone experience in the senior year. Some universities are experimenting with categorizing or "tagging" specific courses that are part of the progression and will explicitly provide general research skills and have "research" as a focus. Some are expanding "research across the curriculum." Many departments are trying to "unstuff" the curriculum by identifying key concepts students should understand and, especially in introductory courses, teaching them through inquiry- or problem-based methods. The greatest attention has been given to the first-year especially to offering "first-year seminars" that are taught by leading faculty and emphasize inquiry and reflection. Universities are also creating a variety of capstone options, such as seminars, interdisciplinary team projects, and service learning experiences.

Changing the University Culture

In what may be the most significant development in this direction, a small number of universities have taken concrete steps to align their emphasis on undergraduate research directly with the university's overall research mission. Duke University, for example, has placed its commitment to undergraduate research at the center of the University's mission. Other universities are similarly engaged in identifying and connecting larger institutional and departmental goals with the goals and desired outcomes for undergraduate education, including a research experience. One outcome of the deliberations at some institutions has been the development and public articulation of a clear rationale for why and how participation in research adds value to the undergraduate experience. While this interest in integrating the missions for research and undergraduate education is relatively new to research universities and not yet widespread, it reflects the increased value these institutions are now giving to undergraduate education and may signal change in the academic culture.

Conference participants offered a wide-range of recommendations for improving the infrastructure at universities to support undergraduate research and increase opportunities:

- Recognize that different activities will lead to different outcomes and that research should not be theorized as a one-size-fits-all experience. Develop multiple outlets to accommodate the diversity of student interests and abilities.
- Ensure that there is a person in place --perhaps in the office that has overall responsibility for undergraduate education or the campus teaching resource center--to work with departments to structure their curriculum to prepare students to engage in in-depth study by their senior year; this position should also help faculty and departments to incorporate research and research-related experiences into curricular and non-curricular activities.
- Take advantage of non-curricular opportunities, such as learning communities, student organizations, and other experiences students may have, to stimulate interest in research. Some examples: Develop learning communities that have research as a central element and are responsive to different disciplinary approaches; use a group research project as a vehicle for strengthening an existing learning community; encourage and assist student clubs to have regularly- scheduled events at which undergraduates, graduate students and faculty report on ongoing work; ask visiting speakers to give separate talks for undergraduates.
- Encourage student-initiated research projects. An undergraduate research office can help here.
- Re-vamp graduate education requirements to encourage graduate students to be more critically involved in undergraduate education, for example, by teaching modules on their own work as part of a course, or supervising a student, or participating in a mentoring chain comprised also of faculty, postdoctoral fellows and undergraduates. Offer these options as an alternative to classroom teaching or the standard teaching assistantship, not as an additional requirement.
- Establish support services and research opportunities early for students, particularly those from underrepresented groups
- Work with the registrar or appropriate campus official to develop criteria and a procedure for noting completion of a significant research project on students' transcripts.

Engaging Faculty

Engaging more faculty remains a major problem. Conference participants noted the two major obstacles. The main one is the academic culture of research universities, which, for the most part, still does not value nor reward efforts directed at undergraduates. The second obstacle derives from many faculty members' lack of knowledge and understanding of how to transform their undergraduate courses or pedagogy to maximize learning.

Faculty Tenure, Promotion, and Rewards

"Reform the existing faculty reward system" was on the recommendation list of more than half of the breakout sessions and ranked second to "defining undergraduate research" as an issue that needs to be addressed by the Reinvention Center and individual campuses. Faculty rewards and incentives are central to all efforts related to undergraduate education. In order to convince faculty that undergraduate education is high on the university's agenda and persuade them to contribute in a meaningful way, campuses must revise their tenure, promotion and merit processes to truly recognize engagement in undergraduate teaching. Such revision will not only serve to attract more faculty, but it will signify an important shift in values and commitment within the upper administration and departments.

Based on the groups' comments, little progress has been made in this area. If there has been any shift since the previous conference, it appears to be a growing frustration. Several of the breakout groups offered concrete steps that university leaders could take immediately to "at least start the process:"

- Develop mechanisms, such as release from a teaching or committee assignment, for rewarding "special" or "extraordinary" contributions to undergraduate education. Such mechanisms would go a long way toward attracting more faculty to these efforts.
- Undertake a major evaluation of teaching loads, acknowledging the "real" time many activities require (including weekend and summer work outside of the classroom) and inequities that may exist. Use this information as a basis for assigning responsibilities within a department and giving rewards.
- Develop criteria for evaluating non-traditional and non-disciplinary research (i.e. studies of classroom pedagogical practices) so that it can be brought to bear in tenure and promotion considerations and other faculty rewards.
- Develop criteria for recognizing and rewarding interdisciplinary research and teaching.

The Reinvention Center was urged to survey campuses, identify those that have successfully integrated undergraduate teaching considerations into their reward systems, and issue a report describing these models. Publicizing approaches that have been implemented successfully at peer universities will put pressure on senior administrators at more recalcitrant institutions. The Reinvention Center should also work with campuses to find ways to encourage change and achieve consensus in relation to the value and rewards system.

Faculty and Graduate Student Professional Development

If active involvement in the research process is viewed as an important component of the undergraduate experience, what needs to happen in the classroom to enable students to gain the knowledge and skills essential for meaningful participation? Faculty and graduate students who were at the conference are clearly struggling with this question. Several groups suggested that campuses offer forums at which faculty and graduate students share best practices and learn about effective programs at other campuses. Undergraduates should be invited to occasional programs so that faculty and graduate students can gain from their perspectives. Another suggestion was for campuses to institute a mechanism (or program) to provide long-term professional development for faculty and graduate students. The breakout groups proposed a wide range of topics that such programs might address:

- Integrating research-related processes and methods into class activities, particularly in large classes
- Incorporating one's own work into a course syllabus
- Establishing criterion-based grading
- Assessment: Topics here range from assessing and improving one's own teaching to developing course goals and objectives that can be assessed in multiple ways, to developing skills in using techniques like a goals inventory for faculty and students when revising a course/curriculum
- Recent research advances on learning; translating basic principles of learning into one's own teaching
- Using principles of learning in shaping research experiences and supervising undergraduates
- Disseminating research on student learning within one's professional outlets
- Pedagogical strategies and techniques, such as inquiry-based teaching methods, collaborative learning models, group assignments, discovery-oriented demonstrations, more meaningful lab experiments and other approaches
- Using technology as a tool to improve teaching and learning

Breakout groups that focused on graduate education recommended that undergraduate teaching be made a required component of graduate education and that graduate students receive formal training for this role. This training should include reading literature on learning that can inform their design and teaching of a course.

Several breakout groups recommended that the Reinvention Center become more aggressively involved in professional development activities. Possible roles the Center might play include:

- Forming long-term networks and/or support groups to maintain, implement and advance discussion and implementation of changes in teaching intended to create active learning environments for all students. Include graduate students in these groups.
- Sponsoring forums for faculty and graduate students that focus on productive ways to connect graduate and undergraduate education. Topics that might be addressed include:
  - Linking goals and desired outcomes for students with course content and activities
  - Integrating the processes of research (thinking process, practice, and methods) into undergraduate teaching
  - Being an effective mentor
  - Addressing gender and cultural issues instructors might face in the classroom
  - Integrating advances in research into undergraduate teaching
  - Research as a vehicle for a truly interdisciplinary education
  - Using principles of learning to inform the research experience.
- Creating an inventory of initiatives like ORDER in which graduate students serve as conduits to connect the undergraduates with faculty at the university.
- Taking advantage of the unity of conference participants in valuing graduate student teaching to bring the message to higher levels of administration, funding agencies and the general public.
- Holding forums focusing on assessment.

Pedagogy: The Science of Learning

For a substantial number of conference participants, the talks and sessions on the "science of learning" were the most "interesting," "exciting," and "enlightening" part of the conference. A remarkably large number of attendees noted that, prior to the conference, they had been uninterested or skeptical of research on learning and/or its potential to improve either their teaching or their students' learning. However, the opportunity to learn about ongoing research and look at data convinced them otherwise. One participant summarized a sentiment expressed by the majority of attendees who commented on this topic: "There are a lot of 'how to' articles, but they mostly rely on anecdotal evidence. Faculty feel alienated by psychology journals if they lack credible evidence. But today we got to see the data. This was refreshing. I think what is needed are research articles that are acceptable, that are not loaded with jargon and are well supported." Participants were equally impressed by the presentations on technological advances, particularly on how technology can be used to give students and instructors feedback on what students are learning.

Several groups recommended that professional development programs at universities draw more heavily on "good literature" on learning and technology. They should use data derived from well-designed and executed studies to educate faculty and graduate students about different aspects of learning and to assist them in translating specific findings into their teaching and research supervision. In addition, these programs should acquaint faculty with various technologies that are available as tools to improve and assess teaching and learning.

The Reinvention Center was urged to continue to emphasize the "science of learning" at regional network meetings and future conferences and at workshops focusing on teaching and learning within specific disciplinary and educational contexts.

Improving the Infrastructure

Conference participants emphasized the importance of having a well-functioning infrastructure to support the various components comprising undergraduate education, and they offered numerous recommendations to individuals and to the Reinvention Center for strengthening existing approaches. The recommendations, which touch on virtually every aspect of undergraduate education at a research university, range from establishing broad goals to undertaking specific actions. The most frequently-mentioned recommendations are listed here:

Recommendations for Campuses

- Assessment
  - Establish a centralized mechanism for assessing campus-wide initiatives, such as honors programs and learning communities, both for their immediate impact on student learning and their long term impact.
  - Establish a process and provide tools to enable faculty, departments or a centralized office to perform assessments to compare pedagogical innovations to standard methods.
- Strengthen the infrastructure to support research-based teaching
  - Create teams with expertise in pedagogy, library collections, and educational technology to assist faculty in designing and implementing undergraduate courses.
  - Establish a repository of effective practices.
- Establish campus-wide mechanisms to assist and support departments and students in undergraduate research
  - Develop readily-accessible mechanisms to help students find appropriate research placements.
  - Sponsor workshops for student on proposal writing in the field so that they may learn to better communicate and explain their work.
- Connect undergraduate research with efforts to elicit funding for research-based undergraduate activities.
- Establish productive partnerships with other educational institutions and local organizations.
- Promote interdisciplinarity by developing policies that encourage interdisciplinary teams to design and teach core courses. Ensure that team teaching is counted in giving teaching assignments.
- Access and Retention
  - Help students from underrepresented groups connect with one another by establishing communities of scholars.
  - Build partnerships with high schools and neighboring communities. Include families in these efforts.
  - Create mechanisms to facilitate the integration of transfer students.
  - In promoting research and research-related courses, go beyond the natural pool and try to attract students who may not be inclined to register for research-oriented courses, but would really benefit from them.
- Link the construction and renovation of academic facilities with new modes of teaching.

Recommendations for the Reinvention Center

- Take a lead role in promoting and expanding undergraduate participation in research and creative endeavor.
  - Invite undergraduates to regional network meetings and conferences to talk about their work and how it has affected their educational and professional goals.
  - Make connections with publishers who produce resource materials, organizations that fund the arts, and organizations with overlapping interest, such as the AACU, Council of Undergraduate Research and National Conference on Educational Research.
  - Convene mini-workshops or interventions between the bi-annual conference to continue problem solving on specific issues.
  - Conduct a study on how universities provide undergraduates with academic credit or pay for research activities.
- Direct special efforts at the humanities, lettered social sciences and the arts.
  - Initiate discussions with professional societies about publishing papers by multiple authors, including undergraduates.
  - Compile effective models and success stories that show ways of engaging humanities students in research activities and share them, using the Web, regional network meetings, and other Center mechanisms.
  - Sponsor forums, perhaps through the regional networks, that focus on issues specific to the humanities.
  - Work with faculty in the arts to develop strategies for educating committees that award research grants about what "research" is in the arts and why it is important.
  - Compile and disseminate information on funding and resources.
- Lead an effort to develop coordinated strategies for changing the "culture" of large research universities regarding undergraduate participation in research.
  - Organize multi-campus undergraduate research conferences, either by discipline or by region.
  - Create venues --such as research symposia at which students

and faculty together give presentations, or Web-based success stories—to promote interdisciplinary research by students.
    - Encourage funding agencies, such as the NSF, to give greater priority to individual and collaborative research projects that involve undergraduates.
    - Include discussion of strategies to implement institutional change successfully at future conferences and regional network meetings.
    - Work with professional societies and scholarly networks to effect change.
    - Continue and expand the Center's role as a repository for information on best practices and model programs.
- Provide leadership in making educators at universities aware of research on teaching and learning and helping them to translate this research in their own teaching.
    - Create inventories of useful resources on professional development and make them readily available to member universities.
    - Assist in the development and dissemination of new technologies, such as Web tutorial templates, by bringing together the required expertise, and making information about the technologies available to Center constituents.
- Assist campuses to form productive partnership.
    - Identify opportunities for inter-institutional collaboration
    - Compile an inventory of resources that provide models of good partnerships and partnership formation. These resources should describe successes and failures encountered while establishing partnerships.
- Assist campuses to improve their programs.
    - Conduct multi-campus assessments of similar activities to determine their short- and long-term impact on student learning and their overall experience at the university; distill the elements that are critical to a program working well.

Subjects for Future Reinvention Center Activities

All the breakout groups were asked to give the Reinvention Center two or three recommendations for follow up to the conference. The five "top" recommendations, in the priority in which they were put forward, were:

- To work with colleagues to develop an agreed upon definition of undergraduate research
- To develop consensus on criteria for recognizing and rewarding efforts directed at undergraduates
- To continue to emphasize the science of learning by sponsoring forums with this focus and developing and disseminating information on ongoing research and good resources
- To provide leadership in effecting a cultural change at research universities
- To direct special efforts at the humanities and the arts

Further, in addition to the regional network meetings, the Reinvention Center was urged to hold "specialized" workshops that focus on these and other specific topics and to develop task forces and/or networks to undertake in-depth study of some of the most critical and penetrating issues.

Pre-Conference Meetings

Vice Presidents/Provosts/Deans for Undergraduate Education and Other Individuals Who Have Campus-Wide Responsibility for Undergraduate Education

Leaders: Ellen Woods, Senior Associate Vice Provost for Undergraduate Education, Stanford University; and Alan Wyner, Dean, Undergraduate Studies, College of Letters & Science, University of California, Santa Barbara
Recorder: Susan L. Pasin, Assistant to the Director, The Reinvention Center

This meeting was directed at senior officials at research universities whose charge is to represent undergraduate academic interests at the University and provide campus- or college-wide leadership in developing, maintaining and supporting undergraduate academic programs. In many cases, the position of VP (or its equivalent) is relatively new and still evolving; at other institutions it has long existed, but may have undergone transformation in recent years. Whether at public or private or large or small universities, individuals in this position face similar problems and challenges and could well benefit from learning about one another's experiences. The purpose of the meeting was to explore the feasibility of establishing a network of these individuals. The UVP network, as it will be referred to here, would serve as a resource and as a forum for members to share experiences and information, discuss common problems and strategies to address them, plan joint or multi-campus projects, develop institutional data on undergraduate issues, develop position statements on relevant issues, and use data and group positions to develop leverage on their own campuses.

The driving question was: assuming such a network existed, what would be its goals? What purpose would it serve? What kind of activities could it realistically undertake? What could it hope to accomplish? Participants described the problems they are currently facing on their campuses and/or the subjects they would be interested in discussing with other members of a UVP network. Because of the diversity of interests among those present, the group agreed to produce a list of challenges they face. These include:

1. A panoply of problems related to general education at research universities
2. Effecting a movement from traditional lecture style teaching to different types of curricular and extracurricular instructional modes
3. Faculty engagement in undergraduate research
4. Hiring, valuing, and tenuring faculty based on their disciplinary achievements: where does undergraduate teaching fit in?
5. Creating an infrastructure to support interdisciplinary education
6. Department major advising and its relationship to undergraduate research
7. Honors programs
8. Pre-med education
9. Study abroad

Vice presidents, provosts, and deans are responsible for a wide array of policies and activities relating to undergraduate education, but they are often impeded in planning and decision making by a lack knowledge or experience in specific areas. These may range from strictly administrative to academic matters. How can they, for example, effectively assist a collaborative effort of multiple disciplines if their training is in just one discipline? While they can get important input from colleagues on their own campuses, one value in forming a UVP network would be the opportunity it would afford members to consult with peers in similar positions but with diverse academic backgrounds. Among the group attending the meeting, for example, were individuals from the humanities, social sciences, physical sciences, fine arts, engineering, and business.

There was general agreement that while list-servs offer UVPs one means of communication and could provide a useful function, their uses are limited. The consensus was the real value of a UVP network would be the interaction it would foster among members, the opportunity it would for afford for them to get to know one another, share best practices and strategies for situations ranging, for example, from developing new programs to innovative approaches to teaching, to revamping criteria and procedures used to evaluate faculty for promotion and tenure to give more attention to undergraduate teaching. The network would be equally valuable in promoting collective study and developing strategies to address the most common and persistent challenges. One such challenge is the effect that scaling up undergraduate research activity and increasing pressure on faculty to supervise undergraduates might have on faculty who already have full agendas.

Another function of a UVP network might be to facilitate sharing of data on critical issues such as retention. By sharing data, campuses would have a context in which to evaluate their own efforts. Collectively, they might use the data to develop standards to which individual universities might strive. Such data might give UVPs leverage in arguing for resources on their own campuses. One area that participants felt would benefit from common data analysis is undergraduate research. If, for example, campuses collected and compared data on the number and percentage of undergraduates participating in research, collectively and by majors, they would be able to achieve a better understanding of their own campus efforts and identify areas for improvement.

Support for undergraduate research is limited and the funds do not spread very far. One way to create more opportunities and accommodate more undergraduate researchers is through active collaboration among universities. The UVP network could be a mechanism for UVPs to learn about their counterparts' interests and priorities, identify areas of mutual interest, connect faculty who share these interests, combine resources and strengths, and facilitate collaboration for the purpose of intellectual and financial productivity.

The group felt there would be value in their developing a collective, national voice to serve as an advocate for undergraduate education and raise critical issues with state legislators and policy makers, disciplinary societies, and public and private funding organizations, as well as among ourselves. The UVP network could become such a voice. In establishing itself, the Reinvention Center and network members would probably find it useful to look at organizations that might serve as good models. Research university Presidents, Provosts and Deans/Vice Presidents of Graduate Education all belong to groups with similar agendas. These groups could provide insight on productive strategies for developing and maintaining the UVP network. With reference to UVPs specifically, there are two good models that should be investigated. One group is made up of the ten UVPs from the University of California system. The second group is composed of UVPs from CIC institutions. Members of both of these groups were present at the meeting and were supportive of efforts to form a UVP network, as they indicated the benefits they personally derived from interacting with their peers. Aside from UVPs at UC and CIC institutions, no one attending the meeting knew of or had participated in a meeting which had the various roles and responsibilities of UVPs as its focus.

Some participants expressed skepticism about creating a new organization. One concern was the extent to which the UVP network activities would be redundant with the activities of other groups. We should investigate existing organizations such as NASULGC which has subcommittees concerned with undergraduate education. If the idea of the UVP network were to proceed, what would be its unique characteristics? Who would be eligible? These issues would need to be addressed if this concept of a network were to progress to the next level. The Reinvention Center would provide staffing for and foster conversations and activities concerning the development of the UVP network.

Recommendations

- The group agreed that the UVP network could be a valuable resource for senior officials at research universities and recommended that the Reinvention Center continue the discussion about its possible development.
- As a first step, the Reinvention Center should create and distribute a list of the participants at this initial meeting to facilitate communication.
- Several recommendations were made for following up on this initial meeting. One option is for the Center to convene four regional meetings that would be scheduled to coincide with the regional network meetings. This approach would allow small groups of UVPs from the same area to engage in the kind of in-depth discussion that is not possible within a large group setting. A second option is to schedule a meeting within the context of a national disciplinary conference. This option would work well for UVPs who share similar interests. The third option is a stand-alone meeting for all interested UVP. The first such meeting could be planned for next year, when the Reinvention Center will not be hosting a conference. Another suggestion was to invite individuals to visit each others' campuses in order to discuss similar interests.
- It was suggested that the Reinvention Center work with a group of UVPs to plan and offer professional development courses for UVPs.

Undergraduate Research Program Directors, Faculty and Professional Staff with Responsibility for Promoting, Coordinating and Expanding Undergraduate Research Opportunities

Leader: Sandra R. Gregerman, Director of the Undergraduate Research Opportunities Program, University of Michigan
Facilitators: Michael Bergren, Assistant Dean, Office of Academic Services, Massachusetts Institute of Technology; Linda Blockus, Director, Office of Undergraduate Research, University of Missouri; Laura Damuth, Academic Coordinator for Undergraduate Research, University of Nebraska at Lincoln; Janice DeCosmo, Assistant Dean of Undergraduate Education, University of Washington; Patricia Pukkila, Associate Professor of Biology and Director of the Office of Undergraduate Research, University of North Carolina-Chapel Hill; and Janet Stocks, Assistant Vice Provost for Education, Carnegie Mellon University

This meeting brought together faculty, administrators and professional staff who work in an undergraduate research office and/or have broad responsibility for expanding undergraduate research opportunities, whether at the university, collegial or departmental level. The purposes were to discuss issues impacting individuals and offices with responsibility for expanding undergraduate research; to share best practices in terms of expanding undergraduate research; to discuss institutional barriers and how to overcome them; to share ideas about how to provide access and entry to diverse students as defined in numerous ways (e.g. first and second year students, underrepresented students, students in non-science fields, etc.), best practices for recruiting students and faculty, support services provided for students and faculty research sponsors, the role of graduate students, etc. Less attention was actually paid to discussing basic office functions, and much more to broader campus issues and practices campuses in light of both opportunities and challenges, share ideas and strategies, exchange

materials, and examine questions that are basic to providing essential support and service in this area to undergraduates, faculty and departments. The group also considered establishing a "home base" and forming a formal network of individuals associated with undergraduate research offices. There seemed to be considerable interest in this. Several attendees remarked that the list of topics outlined below would be excellent content for a conference specifically targeted to administrators and others responsible for expanding and centralizing undergraduate research efforts at research universities.

Format

After briefly introducing herself and the session facilitators, session leader Gregerman noted the growth of undergraduate research at research universities, the remarkable increase in people involved in undergraduate research programs, and the increasing interest in topics related to centralized undergraduate research programs. The large registration for this meeting is evidence of this interest. The meeting attracted close to 150 participants--five times the 30 individuals who attended a similar meeting at the Reinvention Center conference in 2002. Gregerman then identified some of the common issues and challenges facing administrators of centralized undergraduate offices, regardless of the size of their institution or whether it is a public or private university. These include:

- The merits and challenges of centralizing undergraduate research programs
- Engaging all students, in all majors, at all levels and with varied backgrounds and interests
- Expanding programs across all disciplines
- The merits and challenges of involving students at all levels, including those in the freshman year and perhaps even pre-freshmen
- The difficulty facing departments with a large number of majors and a lack of traditions or models
- Curricular and co-curricular initiatives to support expanded undergraduate research and prepare students at different levels and of diverse background to do meaningful research
- Obtaining adequate funding and support for undergraduate research
- Recruiting and engaging faculty; how do you get faculty involved?
- The role campus leaders can play
- Funding and support/culture increased demand for summer research, etc.
- Importance of campus leadership, institutional support, and institutional fit
- Engaging the Professional Schools

Because of the size of the audience, to facilitate discussion, participants were divided into five groups, led by faculty and administrators with considerable experience in undergraduate research. Since the facilitators came from different types of institutions and collectively had expertise in a wide range of areas, they were able to comment on the varied situations of members of the audience.

Each session was organized around a particular issue, though the specific topics they addressed were often interrelated.

Group One: Starting a Centralized Program

1. What are some current models of centralized programs? What is their scope and what is the range of responsibilities they might have?
2. Where are they housed institutionally? What are the benefits and what are the shortcomings? How do they interact with departments?
3. Who are the students they typically serve?
4. How are faculty recruited; what incentives are provided to faculty?
5. Who are important partners/allies in establishing such programs?
6. What support/compensation is offered to faculty? Students?
7. How does one evaluate and assess these programs; why is it important to evaluate them?

Groups Two and Five: Best Practices

1. Once a program has been established, what specific issues do its director and staff face and wish to discuss?
2. What is the role of graduate students and postdoctoral fellows in your program?
3. What challenges may you be facing as you try to expand your program-- either in terms of size, disciplines, or student populations? Do you have specific targets?
4. Is there interest in developing a group/listserve/presence at national meetings with targeted workshops for program directors/administrators? What topics are of interest to you?
5. What strategies and/or practices have you employed that have been particularly effective?
6. Do you do an annual report?

Group Three: Engaging and Preparing 1st and 2nd year Students for Meaningful Participation in Research

1. What are the different models of preparing lower level students for participation? How do they vary across disciplines? What role does general education play?
2. What are some effective curricular models? Does your campus offer seminars for 1st and 2nd year students? Who teaches them? To what extent and how are graduate students involved?
3. What are some effective co-curricular models?
4. What are some effective models for concurrent preparation with participation in research?
5. What are the unique challenges of engaging younger students?
6. What are the advantages of early engagement?

Group Four: Involving Students in All Disciplines

1. What are some curricular and non-curricular models of engaging students in fields that do not have an undergraduate research tradition, e.g. humanities and creative arts?
2. How are faculty enticed to participate? What are perceived barriers to research collaboration?
3. How have different institutions or individuals created innovative models to incorporate all disciplines?
4. Are there other disciplines beyond the humanities and creative arts that present special challenges? How have people worked to overcome these challenges? What are some of the more successful strategies and/or models you have used?

Despite the different foci of the individual group meetings, there was a remarkable convergence of interests. The main topics of interest were:

- Faculty incentives: Financial rewards, course release, leveraging faculty recognition awards, and creative funding
- Funding challenges: Maximizing the use of faculty awards and minority supplements; the amount and allocation of student stipends, for example, giving smaller amounts financially but

involving more students v. giving larger amounts to a smaller number of students
- Funding opportunities ("finding your $20 million donor")
- Scalability: Determining the percentage of student that can/should participate in research: How many students can the campus can reasonably accommodate? How do we count students (for example, through courses, capstone projects and theses)?
- Expanding opportunities in the Humanities, lettered Social Sciences, Mathematics and Physics
- Verticality in developing research skills
- Generating and evaluating proposals
- Getting administrative buy-in
- Centralizing v. Decentralization
- What's the first step? (for those starting a centralized undergraduate research program)
- Documentation and Assessment—of learning outcomes, of the impact of undergraduate research

Group 5 spent time discussing additional topics in some detail:

- Undergraduate research journals: The discussion was wide ranging and covered such subjects as the relative merits of encouraging student publication in undergraduate research journals v. peer-reviewed professional journals; the amount of student involvement and initiative in the production of publications; Web v. printed publications, and copyright and conflict of interest issues
- Graduate student involvement: What are the roles and responsibilities of graduate students and postdoctoral fellows as mentors of undergraduate research? Are there ways to involve graduate students so that it benefits them as well as undergraduates?
- How does undergraduate research fit into the national higher education agenda?
- How can campuses engage minorities and women in research?
- Expanding the horizon of research opportunities: international research opportunities, community-based research
- Promoting undergraduate research among students and faculty: The value, for example, of research symposia, undergraduate research awards and prizes, and faculty mentorship awards
- Curricular innovations: The discussion here was wide ranging and touched on such topics as the disciplinary value in "service" courses, the creation of introductory research methods courses, interdisciplinary seminars that involve faculty from different disciplines, community-based research courses, and the use of java applets
- Getting undergraduate research as a line item in the university budget

Group five also identified several useful resources for faculty and professional staff involved in the promotion of undergraduate research:

- *Cell Biology* includes articles on pedagogy
- List serv guru: which lists the names and email addresses of individual involved in the administration of undergraduate research programs
- The CUR and NCUR networks
- Professional societies, such as Cell Biology, the American Society of Microbiology, and Genetics, which feature undergraduate research and undergraduate education at their professional meetings and in their journals.

Session Title: The Reinvention Center Humanities Initiative

Leader: Matthew Santirocco, Professor of Classics, Angelo J. Ranieri Director of Ancient Studies, Dean, College of Arts and Science, and Associate Provost for Undergraduate Academic Affairs, New York University
Recorder: Naomi Frandsen, Graduate Student, Department of English, Georgetown University

Background

The purpose of the meeting was determine how the Reinvention Center can assist humanities and lettered social science departments at research universities to reorient and revitalize their undergraduate education, taking advantage of both the richness of their research and graduate programs and the array of resources that are present at the university. The underlying interest is to create an environment within these departments, and the university, that will promote and support the development of models that will expose students to the background and methods of humanistic study, help them gain an appreciation of its value and relevance, and enable large numbers of students to engage in scholarly activity, in collaboration with faculty, and graduate students. This initiative comes at the urging of about 100 humanities faculty who attended the Reinvention Center's conference in November 2002, or participated in regional network discussions during the past year and who have asked the Center to sponsor more programs on undergraduate humanities education. The initiative is undertaken with a realistic awareness of the constraints imposed by humanities departments' limited resources and by the volume and diversity of the undergraduates they teach.

Among the most penetrating challenges humanities and lettered social science departments face are: a lack of appreciation and understanding of the relevance of humanistic study within both the university and the larger culture; a perceived increasing marginalization within the university; consolidation and/or shrinkage in size; a significant rise in adjunct instructors, particularly in 1st and 2nd year courses; the absence of a tradition that promotes and supports undergraduate scholarship; and a lack of recognition of inquiry-based teaching techniques. While successful confrontation of many of these challenges requires the cooperation and support of the university's leadership, some of these problems are "self-created" and need to be addressed within—by departments, faculty and the disciplines themselves.

Introduction

Session leader Matthew Santirocco opened the session by outlining the context and goals of the evening's discussion. Currently, undergraduate research faces some challenges. Parents are worried that their children will turn into academics instead of investment bankers, people accuse faculty members of wanting to change college into graduate school, and a donor at NYU even took back a large check after hearing that the money might be used for undergraduate research. On the other hand, ironically, professors are also often accused of sequestering undergraduates from the activities of the production of knowledge. While undergraduate participation in research is on the rise in many disciplines, it is lagging in the humanities. A survey of 93 research universities undertaken by the Reinvention Center (2001) found that at 62% of these institutions, more than half of the undergraduates in a laboratory science participate in research. In contrast, at only 21% of these universities do at least half of their humanities students have a research experience; at 52% of the universities, participation is even lower. Although it can be argued that the nature and organization of much scientific research make it easier to involve students, discipline within the humanities nevertheless needs to examine themselves and their current modes of research and teaching to determine why we are

excluding students from what we do. Several factors were mentioned as contributing to this exclusion: Scholarship in the humanities is largely individualistic and solipsistic; it is authority-driven, with the text having primacy; humanities scholars are still asking themselves fundamental about the nature of interpretation and knowledge.

Are the survey findings cause for concern?

Professor Santirocco proposed that the meeting focus on four themes:

- Achieving consensus of definition: What is undergraduate research in the humanities? What is mentoring and what does mentoring of undergraduates in the humanities entail?
- Strategies. Do we have a research methodology? How do we get students ready to do research? What are the prerequisite cognitive skills? What are the perquisite research skills? Who is teaching students—at the lower level and at more advanced levels? How do we develop courses and programs that engage students and systematically prepare them "for the moment of research?"
- Faculty. How do we make it possible for faculty to want to participate in these undergraduate research programs? How do we develop the necessary resources, including time? How will we create incentives for faculty and assess and reward them for this activity?
- What can the Reinvention Center do to promote change and assist universities in their efforts?

Discussion

In an effort to understand the reasons for infrequent involvement by undergraduates in humanistic scholarship, session participants discussed the definition of "research" in the humanities and what meaningful participation in scholarly activity by undergraduates might entail. Research requires a connection to the scholarly process, including engaging in secondary sources, doing library searches, and becoming familiar with a scholarly conversation and its contributing scholars. Non-solipsistic modes of doing scholarship could include editing a manuscript, perhaps a work in progress being written by a faculty member; Web work, such as developing and posting an annotated bibliography on a subject or creating a Web site on a work or author or theme; and socialized forms of knowledge production. Technology for example enables undergraduates to engage in intensive and creative conversations, and even collaborations, with students and faculty at other universities who share their interest. The question was posed whether interpretive activities in class could constitute the "laboratory" work of the humanities.

Research also requires a sharing of knowledge and/or dissemination to a public sphere. For undergraduates, possible venues for dissemination include undergraduate conferences, poster sessions, and classroom presentations. The group spent considerable time discussing what a research experience might be for undergraduates, expectations for students' performance, and curricular strategies for preparing students to do sophisticated in-depth work in conjunction with a senior thesis, upper-division seminar, or other possible forum. There was agreement that the habit and culture of research needs to be inculcated early. A good place to start might be the freshman composition class, where students ideally are introduced to the "intellectual moves" that characterize critical thinking and creative research in a small, highly social class setting. Because the freshman composition and other first-year classes can be so critical to students' intellectual development, they should be taught by experienced faculty who can serve as research models for the students. Too often however at research universities, these courses, taken by the least experienced students, are taught by the least experienced faculty. As a result, students never gain an appreciation of the "moves" nor experience the excitement of discovery, and they are discouraged from continuing in the humanities. In addition, in assigning graduate students and part-time instructors, rather than "regular" faculty to teach introductory courses, departments in effect devalue them and in the eyes of students diminish what they have to offer. At universities like Yale and Princeton, where freshmen are taught by the most esteemed faculty members, such devaluation does not occur, and the courses are well recognized for laying a foundation for further study and scholarly activity.

Students need to learn to become part of a national conversation of scholars in a field. The most obvious way to begin is to engage them in the conversation in class and other settings, from the first year on. The next step is to provide gradual experiences in which they read and work with scholarly materials produced by and about the scholars, their writings and the field. Since communication is integral to scholarship, it was also suggested that humanities programs include teaching speech as well as writing in the first-year composition course, as well as other courses as appropriate.

Finally, the group discussed the best way to create a culture of undergraduate research within university humanities departments. Many schools invite freshmen and sophomores to participate in learning communities that emphasize interdisciplinary discussion and research-motivating inquiry. Many schools also organize undergraduate conferences, poster sessions, yearly banquets and symposiums, and journals of undergraduate research. Humanities and lettered social science departments should take advantage of the opportunities these venues offer, and should figure out ways to position themselves to play a central role in their activities. At the same time, everyone agreed, a genuine culture of research requires the support and participation of significant numbers of faculty members; getting this support represents a major challenge. Here, university and disciplinary leadership can be critical. Departments and the university upper administration need to work together to create the resources of time, money, and support personnel to allow faculty members to engage undergraduates in their work. Possible strategies include: making mentoring a component of advancement, rewarding faculty who supervise undergraduate research, and institutionalizing research by creating an archive of teacher-mentored student research projects that continues from year to year.

Overall, the group emphasized the need to create a conversation across disciplines and across a university and develop strategies for drawing students in. The goal for humanities departments should be to educate students to think of themselves as participants in a scholarly conversation and a system of producing knowledge.

The group also stressed the responsibilities of faculty and departments. Humanists have tended to turn inward and isolate themselves from public conversations on topics such as the environment, bioethics, diversity, globalism, homeland security, and terrorism to which they could make an important contribution. Instead of withdrawing from these conversations, they should join in, make their potential contribution known, and use their knowledge to inform the discussions. And they should be forming alliances with other groups. By re-positioning themselves in this, they would re-assert their relevance and strengthen their position within both the university and the larger culture. They would also attract more undergraduates. It was noted that humanists for the most part have not been part of the conversation nor taken advantage of funding opportunities that exist through the Homeland Security Act, the U.S. Department of Education Graduate Program in Areas of National Need, and the Environmental Protection Agency. The NSF and the NEH have established joint program to encourage humanists to take part in research on a broad range of science-related topics. The Reinvention Center should be encouraged to initiate a series of forums designed to get humanists into a different conversation.

Presenter Biographies

Martha Arnold, Director of Curriculum Development, Center for Teaching and Learning at the University of North Carolina at Chapel Hill. Her interests and work include participatory curriculum assessment and revision, innovative ways to address institutional barriers to interdisciplinary education and the collaborative development of interdisciplinary and multidisciplinary courses and curricula, including those with a focus on undergraduate research and inquiry, service and community-based learning, cultural diversity, and discipline-based writing. Ms. Arnold is collaborating with Dr. Patricia Pukkila and the UNC Office of Undergraduate Research on the Graduate Research Consultant Program, which aims to increase research opportunities for undergraduates in social sciences and humanities courses. She received a B.A. degree from the University of Wisconsin-Madison and an M.Ed. degree from the University of North Carolina at Chapel Hill.

Cathy Birkenstein-Graff, Lecturer in English at the University of Illinois at Chicago. She recently received her Ph.D. from Loyola University in Chicago in American literature. Dr. Birkenstein-Graff writes about Booker T. Washington, the American rags-to-riches story, and what she calls "the democratic, renunciatory body," and also on matters of pedagogy and argumentative writing. She and Gerald Graff have recently completed a textbook, *They Say/I Say: The Basic Moves of Argumentative Writing* (forthcoming, 2005), which features writing templates or scaffoldings that they developed teaching courses in literature and first-year writing. With Gerald Graff, she also gives talks and conducts workshops on their writing method.

Elizabeth Bjork, Professor of Psychology at the University of California, Los Angeles. Prior to joining the UCLA Psychology Department, she was a faculty member at Rockefeller University and at the University of Michigan, and a Visiting Scholar or Visiting Professor at Bell Labs (Murray Hill); Dartmouth College; University of California, San Diego; and St. Andrews University, Scotland. She has served as a member of the editorial boards for *Memory & Cognition* and *Perception & Psychophysics*, and as a member of the Initial Review Group for the NIMH, Basic Behavioral Processes. She is a Fellow of the American Psychological Society. Within UCLA's Psychology Department, she is the Faculty Sponsor for Psi Chi, the National Honor Society in Psychology for undergraduates, and the Psychology Department's Annual Psychology Undergraduate Research Conference; is in charge of the Teacher Training Seminar and Program for Teaching Assistants; and chairs the campus-wide Teaching Assistant Training Committee. She has chaired a number of committees concerned with undergraduate education and campus life, including the Committee on Undergraduate Student Support, Honors, and Prizes; the Committee on Student Development; and the Undergraduate Council, which is the overarching committee for all undergraduate programs and affairs. Dr. Bjork's primary area of research is human memory and the application of cognitive principles to teaching and learning. She is recipient of the Psychology Department's Distinguished Teaching Award. Dr. Bjork has a B.A. in Mathematics from the University of Florida. Her Ph.D. in Psychology is from the University of Michigan.

Gregory Bothun, Professor of Physics and Environmental Science at the University of Oregon. He received his Ph.D. in Astronomy from the University of Washington and has held teaching/research positions at the California Institute of Technology, Harvard University, the University of Michigan, and the University of Oregon, where he teaches classes in astronomy, energy policy, environmental science, the philosophy of science, and physics. He long ago concluded that teaching via lectures was mostly a vehicle to entertain but not educate. He prepared and delivered his first Web-based course in 1993, which pre-dates the Web browser. He has been heavily involved in this enterprise since then, constantly evolving new tools. He now teaches all of his classes—regardless of subject—in a wireless laptop classroom environment for classes ranging in size from 20 to 80. This environment has become a mostly lecture-free zone notable for the heavy emphasis on collaborative interactive exploration of the material.

Nancy Cantor, President and Chancellor and Professor of Psychology at Syracuse University. She received her A.B. from Sarah Lawrence College and her Ph.D. in Psychology from Stanford University. Dr. Cantor's fields of specialization are personality and social psychology, and personality and cognition. Prior to her current appointment, she served as Chancellor of the University of Illinois at Urbana-Champaign; Provost and Executive Vice President for Academic Affairs, Dean of the Horace H. Rackham School of Graduate Studies and Vice Provost for Academic Affairs at the University of Michigan; Chair of the Department of Psychology at Princeton University; and Professor of Psychology and senior research scientist at the Institute of Social Research. The author and co-editor of numerous books, book chapters, and scientific journal articles, she is a fellow of the American Academy of Arts and Sciences and a member of the Institute of Medicine. Dr. Cantor received the American Psychological Association's Distinguished Scientific Award for Early Career Contribution to Psychology and the Anti-Defamation League's Woman of Achievement Award. She served as Chair of the board of directors of the American Association for Higher Education, a member of the National Advisory Board of the National Survey of Student Engagement, a member of various advisory boards and study sections of the NSF and the National Academies, including the Advisory Committee of the Office of Scientific and Engineering Personnel, and recently a member of the Congressional Commission on Military Training and Gender-Related Issues. Dr. Cantor serves on the boards of trustees of the American Council on Education, the American Institutes for Research, the Center for Advanced Study in the Behavioral Sciences, and Sarah Lawrence College.

Pedro Castillo, Professor of History and Provost of Oakes College at the University of California, Santa Cruz. His teaching/research specialization is in 20th-century United States history with a focus on ethnicity/race, immigration, and urbanization, in particular the history of the Mexican American community. He has written essays and books published in the United States and Mexico, including most recently an edited book published in Mexico, *Las Nuevas Fronteras del Siglo XXI/New Frontiers of the 21st Century* (2000) and a co-written book, *The American Nation* (2000), which is a widely used textbook in American history courses in middle schools. Throughout his 25 years at Santa Cruz, he has been involved in undergraduate general education reform. He has also been very active in local, state, national, and international issues outside of the classroom, and was a member of the boards of trustees of the Community Foundation of Santa Cruz County and the Steinbeck Center. He was appointed to the National Council of the NEH by former President Bill Clinton in 1999. Finally, he has lectured extensively in Central America, Mexico, and South America on historical, social/cultural, and political issues in the Latino community of the United States.

Dawn Comeau, joint Ph.D. candidate in Women's Studies and master's candidate in Public Health at Emory University. Her research focuses on sexual identity, behavior, and health. She is an instructor for undergraduate courses in Women's Studies and a teaching assistant for several courses in behavioral sciences in the School of Public Health. As a Howard Hughes Teacher/Scholar, she is working on the evaluation of Origins of ORDER, an interdisciplinary program designed to introduce freshman to graduate students' scientific research.

Reed Way Dasenbrock, Dean of the College of Arts and Sciences and Professor of English at the University of New Mexico. Educated at McGill, Oxford, and Johns Hopkins Universities, he completed his Ph.D. in English at Johns Hopkins. From 1981 to 2001, he taught at New Mexico State University, serving as Head of the Department of English and Associate Dean for Research in the College of Arts and Sciences. He is the author, co-author, or editor of eight books, including, most recently, *Truth and Consequences: Intentions, Conventions, and the New Thematics*. He has published on modernism, post-colonial literature, literary theory, the relations between Italian and English literature from Dante to the present, and on issues facing the profession of literary studies. At UNM, he has inaugurated a University-wide undergraduate research program called PROFOUND (Program of Research Opportunities FOr UNDergraduates).

Ellen Yi-Luen Do, Associate Professor, School of Architecture at Carnegie Mellon University. She received a B.A. in Architecture from National Cheng-Kung University in Taiwan, a Master of Design Studies from the Harvard Graduate School of Design, and a Ph.D. in Design Computing from Georgia Tech. Her research involves the development of freehand sketching, gesture, and physical objects as an intuitive interface to knowledge-based design systems and the areas of computer-based visual analysis tools. Her papers have appeared in journals on artificial intelligence, computer-aided design in architecture and civil engineering, computer graphics, design studies, diagrammatic reasoning, and human-computer interactions. She is a member of the American Institute of Architects, the Association for Computer-Aided Design in Architecture, the Association for Computing Machinery, the Institute of Electrical and Electronics Engineers, and the International Conference on Learning Sciences, and serves on the editorial board for the *International Journal of Architectural Computing*. She has taught computer animation, multimedia authoring, digital design media, graphics programming, and modeling and rendering with computers. Her interdisciplinary freshman seminars on creative problem solving, spatial cognition, and visual thinking have attracted students from all disciplines of arts, engineering, mathematics, and science.

Janet Gail Donald, Professor of Educational and Counselling Psychology at McGill University. She was also former director of McGill's Centre for University Teaching and Learning. Her research focuses on the quality of postsecondary learning and teaching, particularly in fostering higher order learning. She also investigates disciplinary differences in knowledge acquisition and methods of inquiry in higher education. Her most recent book, *Learning to Think: Disciplinary Perspectives* (2002), consolidates 25 years of research on student learning in academic disciplines. A previous book, *Improving the Environment for Learning: Academic Leaders Talk About What Works* (1997), discusses optimal practices for improving student learning. In her writings, Dr. Donald examines a range of topics critical to teaching and learning. They include disciplinary differences in knowledge validation, the role of higher education centers in improving the academy, the evaluation of undergraduate education, and professors' and students' conceptualizations of learning. Her honors include the Distinguished Researcher Award from the Canadian Society for the Study of Higher Education (1994), its Distinguished Member Award (1998), the McKeachie Career Award from the American Educational Research Association (2000), and election as Fellow of the Royal Society of Canada (2001). Dr. Donald earned her B.A. from the University of Western Ontario and her Ph.D. from the University of Toronto.

Diane Ebert-May, Professor of Plant Biology at Michigan State University. Dr. Ebert-May is a leader in promoting professional development, evaluation, and improvement of faculty, postdoctoral teaching fellows, and graduate students who actively participate not only in their own discipline-based research, but also in creative research about teaching and learning. Her work in the assessment of undergraduate learning in science guides many individual faculty as well as science departments. She actively contributes to the educational initiatives of the Ecological Society of America, has served on the National Research Council Committee on Evaluating Undergraduate Teaching and the Committee on Integrating Education with Biocomplexity, is a Fellow of the American Association for the Advancement of Science, and is an advisory board member of the National Academy of Engineering's Center for the Advancement of Scholarship on Engineering Education. Dr. Ebert-May's research group is developing and testing a Web-based concept-mapping tool that enables students in science courses to visualize their thinking online as well as to receive immediate feedback (NSF Assessment grant). In addition, she is the PI of Project FIRST II (Faculty Institutes for Reforming Science Teaching, *http://www.first2.org/*), an NSF-funded national dissemination network for science faculty professional development in teaching through biological field stations and marine labs. Her recent publications describe active, inquiry-based instructional strategies, research designs, and assessment. She teaches plant biology to majors and environmental science to non-majors in large enrollment courses. She recruits and mentors science postdoctoral fellows in teaching- and learning-funded projects. Her plant ecology research continues on Niwot Ridge, Colorado, where she has conducted long-term ecological research on alpine tundra plant communities since 1971. Dr. Ebert-May received her B.S. from the University of Wisconsin, Madison, and her M.A. and Ph.D. from the University of Colorado, Boulder. Her recent course Web site is *www.msu.edu/course/isb/202/ebertmay/2004/home.html*

Sarah C. R. Elgin, Professor of Biology, of Genetics, and of Education at Washington University in St. Louis. She began studying chromatin structure while an undergraduate at Pomona College, benefiting from an NIH-funded summer research program to work in the Caltech laboratory of James Bonner. Completing a Ph.D. with Bonner exploring the role of nonhistone chromosomal proteins, Dr. Elgin did postdoctoral research with Leroy Hood, also at Caltech, developing approaches to study chromosomal proteins in *Drosophila*. She has continued research on chromatin structure in *Drosophila*, making contributions to the analysis of nucleosome arrays as well as detection and analysis of accessible regulatory regions, required for gene activation. Her current research focuses on heterochromatin structure and gene silencing, particularly the role of Heterochromatin Protein 1 (HP1). From 1974 to 1999, Dr. Elgin taught a lecture/discussion course for graduate and undergraduate students on chromatin structure and function. Since 1992 she has served as Director of WU's HHMI Undergraduate Biological Sciences Education Program, which supports curriculum development and summer undergraduate research. She began a "Science Education Partnership" with her children's

school district in the late 1980s that has led both to the development of materials that enable high school teachers to integrate teaching of DNA science and information on the Human Genome Project into their genetics unit (*www.so.wustl.edu*), and to the development of "Hands-on Science" courses for K-8 teachers, taught jointly by scientists and expert teachers. Her current efforts, funded by an HHMI Professors grant, are focused on bringing genomics into both the undergraduate curriculum and the K-12 Science Outreach program at WU. Dr. Elgin serves on the editorial boards of *Molecular & Cellular Biology* and *Molecular Cell*, and is co-Editor-in-Chief of *Cell Biology Education*, an open access journal. She is a member of the University City Science Advisory Council and of the Scientific Advisory Panel for the Encyclopedia of DNA Elements (ENCODE) Project at NHGRI.

Julie Ellison, Professor of American Culture, English, and Art and Design and Founding Director of Imagining America: Artists and Scholars in Public Life at the University of Michigan. Imagining America is a national consortium that fosters the public role of the arts, humanities, and design through building new coalitions and works for structural change in higher education. While Associate Vice President for Research at the University of Michigan, she proposed and led the University-wide Year of Humanities and Arts (YoHA) in 1997-1998. Her undergraduate studies were at Harvard, where she graduated magna cum laude in American History and Literature and her Ph.D. in English is from Yale. With arts and humanities colleagues, she has developed a graduate course and a research seminar on public cultural work and undergraduate courses on "The Poetry of Everyday Life" and "Becoming a Scholar of Conscience." Dr. Ellison has served on the Board of the Michigan Humanities Council as well as on the Michigan Task Force on Creativity, the Arts, and Cultural Education. Her scholarly work ranges across the literature and culture of the 18th and 19th centuries, with particular emphasis on gender, emotion, politics, and genre. She has received an NEH fellowship, along with other research grants and awards and has published numerous scholarly works, including *Cato's Tears and the Making of Anglo-American Emotion* (1999). Her current research project is a study of World Poetry Day and other organized efforts to link poetry and democratic values. She has published poems in a number of quarterlies and magazines.

Renata Engel, Professor of Engineering Design and Engineering Science and Mechanics and Associate Vice Provost for Teaching Excellence at Pennsylvania State University. In the latter role she leads the Schreyer Institute for Teaching Excellence, a unit that has University-wide responsibility to provide support to faculty in areas of teaching and learning, specifically course and curriculum development, educational testing and assessment, and professional enrichment. In her faculty role, she has worked individually and collaboratively to affect changes in the engineering curriculum, primarily to incorporate elements of design in fundamental courses. Her discipline-specific research couples her interest in design and manufacturing with advanced materials. She has modeled liquid injection processes, metal powder compaction, polymer cure kinetics, and powder compact strengthening via high temperatures (sintering). She has also worked with product design: fiber reinforced polymeric grids for reinforcement in concrete and embedded resistance heating element (carbon fiber) designs for making thick fiber reinforced plastic composites. Dr. Engel is active in the American Society for Engineering Education and holds a position on its board of directors. She has been the recipient of several individual and collaborative teaching awards, including the Boeing Outstanding Educator Award and the George W. Atherton Award for Excellence in Teaching. She is a Fellow in the American Society for Engineering Education.

David L. Ferguson, Distinguished Service Professor of Technology and Society and Applied Mathematics and Chair of the Department of Technology and Society at Stony Brook University. A recognized leader in efforts to recruit and retain minority members in science, technology, engineering, and mathematics (STEM), he has directed or co-directed numerous multicampus projects with this focus, including the NSF-funded SUNY Alliance for Graduate Education and the Professorate and the SUNY Louis Stokes Alliance for Minority Participation program. An expert on teaching mathematics, he has been an active contributor in the calculus reform movement, authored numerous papers on problem-solving, quantitative reasoning and education, and is the editor of two books on educational computing. His teaching interests are broad and include co-directing a multicampus project on applications of mathematical sciences throughout the curriculum, an NSF-funded project on innovative approaches to human-computer interfaces, an NSF-supported Algorithm Discovery Development Project, co-designing and co-teaching a multidisciplinary course on "Computer Modeling of Biological Systems," and developing a course in applications of mathematics for liberal arts students. He is coordinator of the Math and Computer Science cluster of Science Education for New Civic Engagement and Responsibility (SENCER), an NSF-funded National Dissemination grant, and he is co-PI of two NSF-funded assessment projects: one a real-time multidimensional assessment of student learning, and the other an assessment of student achievement in undergraduate education. From 1998 to 2002, Dr. Ferguson directed Stony Brook's Center for Excellence in Teaching and Learning. Dr. Ferguson received his M.A. from the University of California, Los Angeles, and his Ph.D. from the University of California, Berkeley. His many honors include the State University of New York Chancellor's Award for Excellence in Teaching (1992); the U.S. Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (1997); and The New York Academy of Sciences Archie Lacey Award (2004), which is presented nationally to an individual who has made extraordinary contributions to the participation of underrepresented minority students in STEM fields.

William Frawley, Dean of Columbian College and Professor of Anthropology and Psychology at George Washington University. He received his Ph.D. in Linguistics from Northwestern University. From 1979 to 2002, when he assumed his present position, he was at the University of Delaware, where he served in the Provost's Office as Faculty Director for Academic Programs and Planning and Director of Undergraduate Studies. Prior to that, for many years, he was Chair of the Department of Linguistics and Director of Cognitive Science. He has authored or edited more than a dozen books, edited several special issues of journals, and published more than 60 papers on language and cognitive science. Recent books include *Vygotsky and Cognitive Science: Language and the Unification of the Social and Computational Mind*; *Making Dictionaries: Preserving Indigenous Languages of the Americas*; and the four-volume *Oxford International Encyclopedia of Linguistics*. He has been an Associate Editor of *Language*, the field's major journal, and is an Associate Editor of *Language in Society*. His current research is on the nature of meaning in language, the computational architectures appropriate to modeling language and mind, and medical informatics and computerized aids to psychiatry. As Dean of Columbian College, he has taken a leading role at George Washington University in promoting discovery and engagement in the undergraduate experience through widespread curricular redesign (especially in the freshman year), undergradu-

ate research, writing-intensive courses, learning communities, and a variety of other efforts to connect undergraduates with senior faculty.

Howard Gardner, John H. and Elisabeth A. Hobbs Professor of Cognition and Education at the Harvard Graduate School of Education. He also holds positions as Adjunct Professor of Psychology at Harvard University, Adjunct Professor of Neurology at the Boston University School of Medicine, and Senior Director of Harvard Project Zero. His numerous honors include a MacArthur Prize Fellowship (1981); the University of Louisville's Grawemeyer Award in Education (1990, the first American recipient); a John S. Guggenheim Memorial Foundation Fellowship (2000); and honorary degrees from 20 colleges and universities, including institutions in Ireland, Israel, and Italy. The author of 20 books translated into 22 languages, and several hundred articles, Dr. Gardner is best known in educational circles for his theory of multiple intelligences, a critique of the notion that there exists but a single human intelligence that can be assessed by standard psychometric instruments. During the past two decades, he and colleagues at Project Zero have been working on the design of performance-based assessments; education for understanding; the use of multiple intelligences to achieve more personalized curriculum, instruction, and assessment; and the nature of interdisciplinary efforts in education. In recent years, in collaboration with psychologists Mihaly Csikszentmihalyi and William Damon, Dr. Gardner has embarked on a study of GoodWork—work that is at once excellent in quality and also socially responsible. The GoodWork Project includes studies of outstanding leaders in several professions—among them journalism, medicine, law, philanthropy, science, and theater—as well as examination of exemplary institutions and organizations. Dr. Gardner's most recent books include *Good Work: When Excellence and Ethics Meet* (2001); *The Disciplined Mind: Beyond Facts and Standardized Tests, the K-12 Education that Every Child Deserves* (2000); *Intelligence Reframed: Multiple Intelligences for the 21st Century* (1999); *Changing Minds: The Art and Science of Changing Our Own and Other People's Minds* (2004); and *Making Good: How Young People Cope with Moral Dilemmas at Work* (with Wendy Fischman, Becca Solomon, and Deborah Greenspan, 2004). Dr. Gardner received his Ph.D. from Harvard University.

Robin L. Garrell, Professor of Chemistry and Biochemistry at the University of California, Los Angeles. Dr. Garrell received her B.S. degree in Biochemistry from Cornell University, and her Ph.D. in Macromolecular Science and Engineering from the University of Michigan, where she was the recipient of Dreyfus and Lubrizol Foundation fellowships. She was an Assistant Professor at the University of Pittsburgh until 1991, when she joined the faculty of the Department of Chemistry and Biochemistry at UCLA. Her research centers on understanding molecular structure at solution-solid interfaces and using those insights to control adhesion and wetting in applications such as microfluidics. At UCLA, Dr. Garrell is the elected Chair of the faculty of the College of Letters and Science, Associate Director of the Institute for Cell Mimetics in Space Exploration (CMISE), a member of the UCLA NSF-IGERT Materials Creation Training Program Executive Board, the Chemistry-Biology Interface Training Program Board, and the Board of the UCLA Alumni Association. She is also a member of the Exotic Materials Institute and the Biomedical Engineering faculty. She serves on numerous journal editorial advisory boards and on several NIH special study sections. Dr. Garrell was President of the Society for Applied Spectroscopy and an elected member of the Coblentz Society Board of Governors. She is the recipient of the Hanson-Dow Award for Teaching Excellence at UCLA, Herbert Newby McCoy Award for Outstanding Research at UCLA, Iota Sigma Pi Agnes Fay Morgan Award, NSF Presidential Young Investigator Award, and in 2003 the UCLA Distinguished Teaching Award. She is a Fellow of the American Association for the Advancement of Science.

Lucia Albino Gilbert, Vice Provost, Professor of Educational Psychology, and Frank C. Erwin, Jr. Centennial Honors Professor at the University of Texas at Austin. An expert in the field of gender studies and career development, she is the author of four books and numerous articles on dual-earner families and gender processes in counseling and psychotherapy. Her current research focuses on gender and technology. As Vice Provost, Dr. Gilbert focuses mainly on undergraduate education and interdisciplinary initiatives. She originated and directs Connexus: Connections in Undergraduate Studies, established in June 2000 to enhance the undergraduate experience. She has received several awards for teaching and research excellence. Dr. Gilbert received her B.A. degree from Wells College and her Ph.D. from the University of Texas at Austin.

Gerald Graff, Professor of English and Education at the University of Illinois. He received his B.A. in English from the University of Chicago and his Ph.D. in English and American Literature from Stanford University. Dr. Graff has been on the faculty at the University of New Mexico; Northwestern University, where he chaired the English Department for six years and later served as Director of the Northwestern University Press; and the University of Chicago, where he was the George M. Pullman Distinguished Service Professor of English and Education and directed and was principal designer of the interdisciplinary Masters of Arts Program in the Humanities, which attracted many high school teachers and led to his active involvement in courses linking secondary school education. Since 2000 he has been at the University of Illinois at Chicago where, in addition to his appointments in the English Department and the College of Education, he was Associate Dean for Curriculum and Instruction in the College of Arts and Sciences, responsible for curricular development and high school teacher education. He is well known for his writings on literature and education. They include: *Poetic Statement and Critical Dogma* (1970; reprinted 1980); *Literature Against Itself* (1979; reprinted 1995); *Professing Literature: An Institutional History* (1987), which is now a standard work on the history of academic literary study in America; *Beyond the Culture Wars: How Teaching the Conflicts Can Revitalize American Education* (1992), which received the 1992 American Book Award from the Before Columbus Foundation and the 1992-93 Frederic W. Ness Award of the Association of American Colleges and Universities; and most recently *Clueless in Academe: How Schooling Obscures the Life of the Mind* (2003), which won the David H. Russell Research Award for 2003 from the National Council of Teachers of English. Many of his ideas on education may be found in *Teaching the Conflicts: Gerald Graff, Curricular Reform, and the Culture Wars*, a collection of essays by him edited by William E. Cain (1993) and in *Falling into Theory* (1993), a textbook edited by David Richter. Dr. Graff's many honors include a Guggenheim Fellowship (1987) and a research fellowship at the Institute for Advanced Study in the Behavioral Sciences at Stanford (1994-1995). His work has been the focus of several academic conferences, including a session on "Conflicts, Culture Wars, Curriculum: A Roundtable on Gerald Graff" at the annual meeting of the MLA in 2001 and a session on "Debating Graff's *Clueless in Academe*" at the 2004 MLA meeting. The theme unifying all of Dr. Graff's work is the need for educational institutions to do more to close the gap between the culture of public discourse and that of students and other citizens. In the 1980s Dr. Graff served on the Advisory Board of the Association of American Colleges and Universities and contributed to an AACU report, "The Challenge of Connected Learning."

Bernadette Gray-Little, Professor of Psychology and Dean of the College of Arts and Sciences at the University of North Carolina at Chapel Hill. Prior to becoming Dean, she was Executive Associate Provost, a position that included major responsibility for faculty personnel review, senior administrative searches and reviews, and budget planning. From 1998 to 2001 she was the Senior Associate Dean for Undergraduate Education in the College of Arts and Sciences with responsibility for undergraduate academic programs. She served as Chair of the Department of Psychology from 1993 to 1998, and prior to that directed the graduate program in clinical psychology. Her research reflects a continuing interest in the relation of social and cultural factors to personality and psychopathology. She has been a Social Science Research Council Fellow, a recipient of a Ford Foundation Senior Scholar Fellowship, and a Fulbright Fellow. She received her B.A. from Marywood College and an M.S. and Ph.D. from St. Louis University. She has chaired or been a member of numerous university boards and committees. Outside the university, Dr. Gray-Little has served on the American Psychological Association's Board of Educational Affairs and the Board of Directors of Division 12, Committee on Accreditation, and she has been a member of the Reinvention Center Executive Board since the Center was established. She has served as an accreditation site reviewer, external consultant for academic programs, and consultant in the leadership development of business and academic executives. She is Associate Editor of the *American Psychologist* and has been consulting editor for several journals.

Sandra Gregerman, Director of the Undergraduate Research Opportunity Program (UROP) at the University of Michigan. She is the Chair of the Board of Governors for the National Conference on Undergraduate Research. She has directed UROP since 1992, overseeing its expansion from 150 students and faculty to 1,200 students and 600 faculty participants. In addition, she was instrumental in the establishment in 1998 of the UROP in Residence Program, a living-learning program focused on research. Prior to assuming her position with UROP, Ms. Gregerman was the Director of Academic Programs for the University of Michigan's School of Natural Resources. She received her bachelor's degree in political science from the University of California, Davis, and her master's degree from the University of Michigan School of Natural Resources and Environment. In her work and writings in higher education, she has focused on issues related to women in science; the retention of historically underrepresented students of color; and the development, implementation, and assessment of undergraduate research programs. Ms. Gregerman is the recipient of an Outstanding Freshman Advocate Award from the National Resource Center for the Freshman Year Experience. Under her leadership,the UROP has won a Hesburgh Award, an NSF Recognition Award for the Integration of Research and Teaching, and a White House Presidential Award for Excellence In Science, Engineering, and Mathematics Mentoring.

Milton D. Hakel, Ohio Board of Regents' Eminent Scholar in Industrial and Organizational Psychology at Bowling Green State University. He received his Ph.D. in Psychology from the University of Minnesota. Dr. Hakel chaired the Coordinating Committee for the Human Capital Initiative, a national effort to bring psychological science to the attention of governmental and private sector officials as a source of solutions to national problems. He serves on the Board on Testing and Assessment of the National Research Council. Recently he co-chaired a working retreat on "Applying the Science of Learning to University Education." An edited book on this topic was published in March 2002. Dr. Hakel's major current interest is in the role of formative assessment in learning and performance. At Bowling Green he chairs the Student Achievement Assessment Committee and the Electronic Portfolio Steering Committee, committees that have identified learning outcomes in majors and for the university as a whole, and also have begun building the means for students to document their own learning and development. He created Springboard, a first-year experience course that involves students and their coaches in meaningful assessment and self-development though a series of activities, some of which are recorded on video for later feedback and reflection. He chaired the team that created BGSU's Academic Plan, and presently chairs a task force that is investigating the creation of a Ph.D. program in learning and teaching with an emphasis on math and science. He is a fellow of the American Psychological Society, the American Association for the Advancement of Science, and the Society for Industrial and Organizational Psychology.

David Michael Hertz, Professor of Comparative Literature at Indiana University, Bloomington. His books include *The Tuning of the Word: The Musico-Literary Poetics of the Symbolist Movement; Angels of Reality: Emersonian Unfoldings in Charles Ives, Wallace Stevens, and Frank Lloyd Wright*; and *Frank Lloyd Wright in Word and Form*. Dr. Hertz has written on architectural history, drama, modern poetry, and music. Also a composer and pianist, he is the co-founder of the Center for Comparative Arts Studies at Indiana University. Dr. Hertz has received grants from the Mellon and Graham foundations, and he is listed in *Who's Who Among College Teachers* (2002 edition). He was recently appointed to the National Council on the Humanities. He earned his B.A. (Comparative Literature), B.S. (School of Music), and M.A. (Comparative Literature) degrees at Indiana University. His Ph.D. in Comparative Literature is from New York University.

Laura Hess, Associate Director for the Humanities and Social Sciences, the Harriet W. Sheridan Center for Teaching and Learning at Brown University. She received her B.A. in East Asian Studies from Yale University, and her M.A. and Ph.D. in Asian Languages and Literature from the University of Washington. Before joining the Brown University faculty in 1996, she was a Visiting Assistant Professor at St. Olaf College for two years. For eight years, she was an Assistant Professor of Chinese in Brown's Department of East Asian Studies, where she taught modern and classical Chinese. Her publications include articles on various sinological and linguistic topics. In addition to her work at the Sheridan Center, she has been an advisor for freshman, sophomore, and study abroad students.

Elliot Hirshman, Chair and Hunt Professor of Psychology at George Washington University. He received his B.A. in Economics and Mathematics from Yale University and his M.A. and Ph.D. in Cognitive Psychology from the University of California, Los Angeles. Previously, he served as Chair of the Department of Psychology at the University of Colorado at Denver, as Special Assistant to the Provost at the University of North Carolina at Chapel Hill, and as an American Council on Education Fellow in the office of the Provost at Arizona State University. Dr. Hirshman's research focuses on biological, cognitive, and computational models of learning and memory. He has served as Associate Editor of the *Journal of Experimental Psychology* since 2000 and previously served as Associate Editor of *Psychonomic Bulletin & Review* and on the editorial boards of the *Journal of Experimental Psychology* and *Memory & Cognition*. Dr. Hirshman is the author of more than 100 peer-reviewed papers and conference presentations in the area of learning and memory.

Patricia Iannuzzi, Associate University Librarian, Director of the Main and Undergraduate Libraries, and Director of Library Collections at the University of California, Berkeley and Designate Dean of Libraries, University of Nevada, Las Vegas. She has held previous positions in libraries at Florida International University, Tufts University, and Yale University. She chaired the task force sponsored by the Association of College and Research Libraries that worked with the American Association of Higher Education, the Middle States Commission on Higher Education, and other higher education representatives to develop Information Literacy Competency Standards for Higher Education. She speaks and publishes on topics related to the educational role of the library, information literacy and accreditation, information literacy and collaboration, and student learning outcomes and assessment, and has been a consultant to the Andrew W. Mellon Foundation to review its grant projects awarded to consortia of liberal arts colleges for information literacy/information fluency.

Dennis C. Jacobs, Professor of Chemistry, Faculty Fellow of the Center for Social Concerns, and Vice President and Associate Provost at the University of Notre Dame. In addition to establishing a laboratory research program focused on exploring the reaction of energetic molecular ions with solid surfaces, he has developed and assessed various innovative strategies for teaching chemistry to undergraduate students. For example, in a partnership with several community organizations, Notre Dame chemistry students use their laboratory expertise to address the problem of lead-poisoning among children in impoverished neighborhoods within South Bend, Indiana. Dr. Jacobs was named a 1993 Alfred P. Sloan Research Fellow, a 1999 Carnegie Scholar, and the 2002 U.S. Professor of the Year for Doctoral and Research Universities. Dr. Jacobs received his B.S in Chemistry from the University of California at Irvine and his Ph.D. in Physical Chemistry from Stanford University.

Victor Jaime, Vice President for Student Services at Imperial Valley College. Dr. Jaime received his Ed.D. in Educational Leadership from Northern Arizona University. He has served as Dean of Financial Aid and State Programs and Project Director of TRIO, a program that prepares and assists community college students transferring to four-year institutions. Dr. Jaime was a community college transfer student from Imperial Valley College to the University of California system.

Elizabeth Jones, Schwertz University Professor of Life Sciences, Head of Biological Sciences, and Howard Hughes Medical Institute Professor at Carnegie Mellon University. She holds a B.S. in Chemistry and a Ph.D. in Genetics, both from the University of Washington. After postdoctoral work in microbiology at the Massachusetts Institute of Technology, she joined the faculty at Case Western Reserve University in 1969. She joined the Carnegie Mellon faculty in 1974. Her research is in the molecular genetics of the yeast *Saccharomyces cerevisiae*. She teaches genetics and has been collaborating on the development of the Genetics Cognitive Tutor since 2001. She received a science college teaching award at CMU in 1984 and the Robert Doherty Award for sustained excellence in teaching from CMU in 1994, primarily for initiating and entrenching undergraduate research as an integral part of the Carnegie Mellon education. She directed CMU's NSF-REU site for undergraduate research from 1987-1995, the Beckman Scholars Program from 2000-2001, and the Howard Hughes Medical Institute Undergraduate Biological Sciences Education Program from 2000 to the present. She is Editor-in-Chief of *Genetics* and a member of the American Academy of Microbiology. She belongs to the American Association for the Advancement of Science, the American Society for Cell Biology, the American Society for Human Genetics, the American Society for Microbiology, and the Genetics Society of America.

Kenneth Kotovsky, Professor of Psychology at Carnegie Mellon University. He also directs the undergraduate program in psychology at CMU where he has been on the faculty since 1988. He holds a B.S. from the Massachusetts Institute of Technology and an M.S. and Ph.D. in Psychology from CMU. His research is focused on cognition, and in particular the cognitive processes involved in problem solving. He uses empirical and computer simulation methodologies to study problem solving. Some of the issues his work has focused on include factors that influence problem difficulty, the early stages of the acquisition of expertise, and how the representation of problems influences the above. He is particularly interested in the processes involved in creative engineering design as well as the role played by non-conscious processes in all these problem-solving activities. He has been awarded the Karl Taylor Compton Prize at MIT, and the University Undergraduate Advising Award at CMU. He is a member of the American Psychological Society, the Association for the Scientific Study of Consciousness, and the Cognitive Science Society.

Ralph W. Kuncl, Provost and Professor of Biology, Bryn Mawr College, and Adjunct Professor of Neurology, University of Pennsylvania. He has been a national leader in the neurosciences. Before becoming Provost at Bryn Mawr College in 2002, he was Professor of Neurology, Pathology, and the Graduate Program in Cellular and Molecular Medicine; Director of the Neuromuscular Pathology Laboratory; and Vice Provost for Undergraduate Education at Johns Hopkins University. There, he created an eight-department multidisciplinary Motor Neuron Study Group, was Associate Editor of the leading international neuroscience journal, *Annals of Neurology*, and conceived and established several University philanthropic funds for research, including the Cal Ripken/Lou Gehrig Fund for Neuromuscular Research. As a teacher, he has won several awards for excellence, including the Frank Ford Award for outstanding teaching in neurosciences and the University of Chicago Distinguished Service Award in 2002. He was the John Kendig Neuroscience Lecturer in 1998. He has trained numerous postgraduate and undergraduate students who have gone on to named fellowships and research awards themselves. The inaugural volume of the philosophy journal, *Prometheus*, was dedicated to his mentoring of undergraduates. As a Fellow of the American Council on Education, he focused his research on how one might best redesign an undergraduate school of arts and sciences that exists within the mission of a strong research university. Most recently, he authored a study of federal underinvestment in higher education research, published in the July 2004 issue of *Academe*. Dr. Kuncl earned both his Ph.D. and M.D. degrees at the University of Chicago. He is a member of the Reinvention Center's Executive Board.

David G. Lynn, Asa Griggs Candler Professor of Chemistry and Biology and Howard Hughes Medical Institute Professor at Emory University. He is in the section of Biomolecular Chemistry and a member of the Center for Fundamental and Applied Molecular Evolution (FAME) and the Center for the Analysis of Supramolecular Self-assemblies (CASS). His research interests include chemical biology, conformational and molecular evolution; molecular skeletons for storing and reading information; nanostructural synthesis and self-assembly; origins of biological order, and self-assembly and signal transduction in cellular development and pathogenesis. Dr. Lynn received his A.B. degree in Chemistry from the University of North Carolina at Chapel Hill and his Ph.D. in Organic/Biological Chemistry from Duke University.

Giancarlo Maiorino, Rudy Professor of Comparative Literature and Director of the Center for Comparative Arts Studies at Indiana University, Bloomington. Since he began teaching at Indiana University in 1972, he has developed courses on the relationship between literature and the visual arts from the Renaissance to the 21st century. He has taught comparative arts at the undergraduate and graduate levels. His scholarship, which includes many books on Baroque, Mannerism, Picaresque, and Renaissance, are all interdisciplinary. He has organized numerous national conferences on comparative and interdisciplinary topics in the humanities. At present, he is writing about the relationship between the Renaissance and Postmodernism. Professor Maiorino received his Ph.D. in Comparative Literature and in Italian, and his M.A. in Art History from the University of Wisconsin, Madison.

Robert Mathieu, Professor of Astronomy at the University of Wisconsin at Madison. He was educated at Princeton University and the University of California, Berkeley, after which he became a Fellow of the Harvard-Smithsonian Center for Astrophysics. He has received a Presidential Young Investigator award and a Guggenheim Fellowship for his research into the dynamics of star clusters and the formation of binary stars. He presently serves as President of the Board of Directors of the WIYN Observatory. Dr. Mathieu also has directed national initiatives for the improvement of science higher education. From 1998 to 2000 he was the Associate Director of the National Institute for Science Education and led the development of the Field-tested Learning Assessment Guide (FLAG) and other resources for science, engineering, and mathematics faculty (*www.wcer.wisc.edu/nise/cl1*). He is the Director of the Center for the Integration of Research, Teaching, and Learning, a five-year NSF-funded Center for Learning and Teaching that focuses on the preparation of science, engineering, and math graduate students for future roles as both forefront researchers and skilled teachers and communicators. Dr. Mathieu received his Ph.D. from the University of California at Berkeley.

Joseph J. McCarthy, Associate Professor of Chemical and Petroleum Engineering at the University of Pittsburgh. He received his Ph.D. from Northwestern University in Chemical Engineering. At Northwestern, he helped develop and was the inaugural participant in the Apprentice Professor Program, an ongoing trainee program for graduate students. He has been on the University of Pittsburgh faculty since 1998. Dr. McCarthy's disciplinary research is focused on transport phenomena in particulate and multiphase flows. His educational interests focus on technology-enhanced teaching/learning and integration of core knowledge early in the curriculum.

Mark A. McDaniel, Professor of Psychology at Washington University in St. Louis. He formerly was the Chair of the Psychology Department at the University of New Mexico and has also been on the faculties at the University of Notre Dame and Purdue University. Dr. McDaniel received his Ph.D. in experimental psychology from the University of Colorado. His focal research interests are encoding and retrieval processes mediating memory, learning of complex concepts such as intervening and function concepts, and how memory and learning can be improved in educational settings. Dr. McDaniel's research interests also include prospective memory and aging. He has authored more than 100 publications, and for the past 17 years his work has been supported by the NIH and by NASA. He is a fellow of the American Psychological Association, has served on numerous editorial boards, including the *Journal of Educational Psychology*, and is former Associate Editor of the *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

Donald McKayle, Choreographer/Director, Claire Trevor Professor of Dance and Artistic Director UCI Dance at the University of California, Irvine. The Dance Heritage Coalition has named him "one of America's Irreplaceable Dance Treasures: the First 100." He has choreographed more than 70 works for dance companies in Canada, Europe, Israel, South America, and the United States, including his masterworks *District Syoryville*, *Games, Rainbow Round My Shoulder,* and *Songs of the Disinherited*, which are considered modern dance classics, and the ten-hour production of *Tantalus*, produced by the Royal Shakespeare Company in collaboration with the Denver Center Theatre Company. The Alvin Ailey American Dance Theater, Ballet San Jose Silicon Valley, Cleo Parker Robinson Dance Ensemble, Dayton Contemporary Dance Company, and Lula Washington Dance Theatre serve as repositories for his works. Mr. McKayle has received honors and awards in every aspect of his illustrious career. His choreography for Broadway musical theater has earned him five Tony nominations: *Doctor Jazz, It Ain't Nothin' But the Blues*, *Sophisticated Ladies, A Time for Singing,* and *Raisin*, which garnered the Tony Award as Best Musical, and for which he received Tony nominations for both direction and choreography. For *Sophisticated Ladies* he was honored also with an Outer Critics Circle Award and the NAACP Image Award. He received an Emmy nomination for the TV special, *Free To Be You and Me*. His work for film includes *Bedknobs and Broomsticks, The Great White Hope*, and *The Jazz Singer*. Other media awards include a Los Angeles Drama-Logue Award for *Evolution of the Blues* and a Golden Eagle Award for *On the Sound*. In dance, he has received the American Dance Guild Award, the Capezio Award, the Dance/USA Honors, the Heritage Award from the California Dance Educators Association, an Irvine Fellowship in Dance, a Living Legend Award from the National Black Arts Festival, two Choreographer's Fellowships from the National Endowment for the Arts, and the Samuel H. Scripps/American Dance Festival Award. In 2003, the Ballet San Jose Silicon Valley and the Lula Washington Dance Theatre both honored him with retrospective programs. For his work in education, he has earned the Balasaraswati/Joy Ann Dewey Beinecke Endowed Chair for Distinguished Teaching, UCI's Distinguished Faculty Lectureship Award for Research, been selected as a prestigious Bren Fellow, and been awarded the UCI Medal, the highest honor given by the University of California, Irvine. Mr. McKayle is Artistic Mentor for the Limón Dance Company. He also served on the faculties of the American Dance Festival, Bard College, Bennington College, Jacob's Pillow Dance Festival, the Juilliard School, Sarah Lawrence College, and was Dean of the School of Dance at the California Institute of the Arts. His real educational credentials, however, reside in generations of students, many of whom are now in professional careers. He has written his autobiography, *Transcending Boundaries: My Dancing Life*, and *Heartbeats of a Dancemaker*, a documentary on his life and work, was aired on PBS stations throughout the United States.

Gail Kern Paster, Director, Folger Shakespeare Library. She is also Editor of *Shakespeare Quarterly*, the leading scholarly journal devoted to Shakespeare, published by the Folger Shakespeare Library in association with George Washington University, where she was a Professor of English and taught from 1974-2002. She earned a B.A. at Smith College, where she was elected to Phi Beta Kappa, and a Ph.D. at Yale University. She has won many national fellowships and awards, including fellowships from the John Simon Guggenheim Memorial Foundation, Mellon Foundation, NEH, and Woodrow Wilson Foundation. She is the author of numerous scholarly articles and three books—*The Idea of the City in the Age of Shakespeare* (1986), *The Body Embarrassed: Drama and the Disciplines of Shame in Early Modern England* (1993), and *Humoring*

the Body: Emotions and the Shakespearean Stage (2004)—and is the co-editor of the Bedford Books *A Midsummer Night's Dream: Texts and Contexts* (1998) and editor of Thomas Middleton's 1607 comedy, *Michaelmas Term* (2000). Dr. Kern Paster has been a trustee of the Shakespeare Association of America and served as President of that organization in 2003. She served two terms as a public member of the Folger Shakespeare Library committee.

Joseph Potenza, Professor of Chemistry at Rutgers University. He received a B.S. in Chemistry from the Polytechnic Institute of Brooklyn and a Ph.D. in Chemistry from Harvard University. Following two years in the United States Army, he entered Rutgers University as an Assistant Professor of Chemistry and became a Professor II (Distinguished Professor) of Chemistry in 1981. He was named University Professor in 1996. With his students and colleagues, Professor Potenza has co-authored more than 140 journal articles. His research interests have included bioinorganic chemistry, boron chemistry, collision mechanics in liquids, and X-ray crystallography . He was an Alfred P. Sloan Fellow and the recipient of an Alexander von Humboldt Senior U. S. Scientist Award. Professor Potenza has taught general chemistry, honors general chemistry, and physical chemistry, as well as several advanced undergraduate and graduate courses. In addition, he co-developed and taught "Impact of Chemistry," a course designed for non-scientists that incorporates group work, essays, problem sets, and field work into the classroom experience. He has twice received the Outstanding Teacher Award given by the Parent's Association of Rutgers College (1974, 1988) and in 2002 received the Rutgers University Warren I. Susman Award for Excellence in Teaching, which is Rutgers's highest teaching award. His numerous administrative positions have included Chemistry Department Chair and graduate director, Associate Provost for Academic Affairs in the Sciences, and Provost and Dean of the Graduate School.

Patricia Pukkila, Associate Professor of Biology and Director of the Office of Undergraduate Research at the University of North Carolina at Chapel Hill. She earned a B.S. degree from the University of Wisconsin-Madison and a Ph.D. from Yale University. She has received both a Chancellor's Tanner Award and a Bowman and Gordon Gray Associate Professorship for excellence in undergraduate teaching. She has organized two multicampus undergraduate research symposia for the North Carolina state legislature in 2001 and 2003. She is a Councilor in the At-Large Division of the Council on Undergraduate Research, a member of the Education Committee of the American Society for Cell Biology, and edits the Genetics Education section of the journal *Genetics*. Her research interests include the genetic basis of meiotic chromosome behavior and fungal genomics.

Judith Ramaley, Assistant Director for Education and Human Resources at the National Science Foundation and President Designate, Winona State University. She has been a professor of biology at five universities, served as President of the University of Vermont and Portland State University in Oregon, and held senior administrative positions at the State University of New York at Albany, the University of Kansas, and the University of Nebraska. She served as Chair of the American Council on Education's Commission on Women in Higher Education and the National Association of State Universities and Land Grant Colleges Commission on the Urban Agenda, and chairs committees of the U.S. Department of Education's National Advisory Council for School-to-Work Opportunities and of the Association of American Colleges and Universities' National Panel on Greater Expectations. Dr. Ramaley holds a bachelor's degree from Swarthmore College and a Ph.D. from the University of California, Los Angeles. She is the author of several seminal publications on educational reform and its relation to society.

Janet Rankin, Associate Professor (Research) of Engineering and Associate Director, Life and Physical Sciences, Harriet W. Sheridan Center for Teaching and Learning at Brown University. She received her Sc.B. in Engineering from Brown University and her Ph.D. in Materials Science and Engineering from the Massachusetts Institute of Technology. Prior to assuming her current position, she was a staff scientist at Oak Ridge National Lab, a Bunting Fellow at Radcliffe College (1991-1992), and Coordinator of the Brown University ExSEL Program, which supports and encourages the participation of traditionally underepresented minorities in math and science disciplines. She received a Visiting Professorship for Women Award from the NSF, which funded her research at Brown during the 1993-1995 academic years. Her current research is supported by grants from the NSF and the U.S. Department of Energy. Her work at the Sheridan Center is focused on graduate student and faculty development, instructional technology, and interdisciplinary teaching and research. Dr. Rankin is a freshman and sophomore advisor, as well as faculty advisor to the Society of Women Engineers (SWE) and the National Society of Black Engineers (NSBE). She teaches a variety of materials science courses as well as general courses in the Engineering Core.

Cory A. Reed, Associate Professor of Spanish Literature at the University of Texas at Austin. He received his Ph.D. from Princeton University. His field of specialization is 16th- and 17th-century Spanish literature. The author of a book on Cervantes's short drama and several journal articles, he is presently completing a book on scientific and technological imagery in *Don Quixote*. Dr. Reed is a past recipient of the President's Associates Teaching Excellence Award. He directs the interdisciplinary Tracking Cultures Program in the College of Liberal Arts, which combines transatlantic studies on campus with research and study abroad to investigate the historical roots of American Southwestern culture in Mexico, North Africa, and Spain.

Jeffrey T. Roberts, Professor of Chemistry at the University of Minnesota at Twin Cities. He received his B.S. in Chemistry from the University of California, Berkeley and his Ph.D. in Chemistry from Harvard University, where he worked under the direction of Cynthia Friend. Dr. Roberts was a postdoctoral fellow at Stanford University from 1988 to 1990 in the laboratory of Robert Madix in the Chemical Engineering Department. He joined the University of Minnesota, Twin Cities Chemistry Department as an Assistant Professor in 1990, and rose through the ranks to become full Professor in 2003. Dr. Roberts' research interests are in the areas of environmental surface science and chemical vapor deposition. He also directs the University of Minnesota Research Site for Educators in Chemistry (RSEC, *www.chem.umn.edu/rsec*), which supports and encourages research collaborations between University of Minnesota chemistry faculty and faculty at primarily undergraduate institutions. Dr. Roberts is the recipient of numerous awards, including a Dreyfus Foundation New Faculty Award, an NSF Special Creativity Award, and a Sloan Fellowship.

Sue Rosser, Professor of History, Technology, and Society, and Dean of Ivan Allen College at Georgia Institute of Technology. She received her Ph.D. in Zoology from the University of Wisconsin-Madison. She has had positions as Director of the Center for Women's Studies and Gender Research and Professor of Anthropology at

the University of Florida-Gainesville, Senior Program Officer for Women's Programs at the NSF, and Director of Women's Studies at the University of South Carolina, where she also was a Professor of Family and Preventive Medicine. Dr. Rosser has edited collections and written approximately 100 journal articles on the theoretical and applied problems of women, science, and technology and women's health, and she has authored nine books: *Teaching Science and Health from a Feminist Perspective: A Practical Guide* (1986); *Feminism within the Science and Health Care Professions: Overcoming Resistance* (1988); *Female-Friendly Science* (1990); *Feminism and Biology: A Dynamic Interaction* (1992); *Women's Health: Missing from U.S. Medicine* (1994); *Teaching the Majority* (1995); *Re-engineering Female-Friendly Science* (1997); *Women, Science, and Society: The Crucial Union* (2000); and *The Science Glass Ceiling: Academic Women Scientists* (in press). She was the Latin and North American co-editor of *Women's Studies International Forum* from 1989 to 1993 and serves on the editorial boards of the *Journal of Women and Minorities in Science and Engineering*, *NWSA Journal,* and *Women's Studies Quarterly*. She has held several grants from the NSF, including "A USC System Model for Transformation of Science and Math Teaching to Reach Women in Varied Campus Settings" and Georgia Tech's ADVANCE grant (co-PI). During the fall of 1993, she was Visiting Distinguished Professor for the University of Wisconsin System Women in Science Project.

Matthew S. Santirocco, Seryl Kushner Dean of the College of Arts and Science, Associate Provost for Undergraduate Affairs, Professor of Classics, and Angelo J. Ranieri Director of Ancient Studies at New York University. Before arriving at NYU, he was Professor and Chair of Classical Studies and Dean of the College of Arts and Sciences at the University of Pennsylvania. He has also taught at Columbia, Emory, and Brown Universities and the University of Pittsburgh. Dr. Santirocco's research and teaching range widely and include the classical tradition, Greek poetry, Latin literature, and mythology. He is the author of a book on Latin lyric poetry, several edited volumes on the classical tradition and on Horace, many scholarly articles, and is working on a book about the poetics of patronage in Augustan Rome. At Penn he developed humanities curricula in the MBA and Executive Education Programs of the Wharton School. At NYU he helped to design a new core curriculum, the Morse Academic Plan, and led faculty in the creation of an undergraduate research initiative, Collegiate Seminars, and a variety of interdisciplinary and interschool programs. NYU's Center for Ancient Studies, which he founded and directs, promotes the development of interdisciplinary courses, annual conferences and colloquia, and summer outreach seminars for faculty from throughout the United States. Dr. Santirocco also has an interest in secondary education, and has directed two NEH Seminars for School Teachers and participated in a year-long NEH Masterworks grant. He has served as Vice President for Professional Matters and is Senior Financial Trustee of the American Philological Association. He was also the Editor of the Association's monograph series, *American Classical Studies*, and is the Editor of the journal *Classical World*. Dr. Santirocco, who is a member of the Reinvention Center's Executive Board, received his B.A. and Ph.D. degrees at Columbia University. He also has an M.A. in Classics from Cambridge and an honorary M.A. degree from the University of Pennsylvania.

Paige E. Schilt, Director of the Bridging Disciplines Programs at the University of Texas at Austin. She earned her Ph.D. in English at UT Austin, where she concentrated on Folklore/Popular Culture/Cultural Studies. Her articles on documentary film and contemporary culture have appeared in film journals such as *Film Quarterly* and *The Velvet Light Trap*. Dr. Schilt has more than ten years of experience working with interdisciplinary undergraduate programs, including the Comparative History of Ideas Program at the University of Washington and the Center for Women's Studies at UT Austin.

Caesar Sereseres, Professor of Political Science, Associate Dean for Undergraduate Studies in the School of Social Sciences, and Coordinator for International Studies at the University of California, Irvine. He received his Ph.D. from the University of California, Riverside. A community college transfer from San Bernardino Valley College to the University of California system, he has served as Chair of the Academic Senate Committee on Undergraduate Admissions and Relations with Schools and a member of the University of California Board of Admissions and Relations with Schools (BOARS). While a five-year member of BOARS, he participated in the creation of new transfer policies and strategies to facilitate the transfer of California community college students to the University of California system.

John Edward Sexton, President and Benjamin Butler Professor of Law at New York University. He joined the Law School's faculty in 1981, was named the School's Dean in 1988, and was designated the University's President in 2001. President Sexton is a fellow of the American Academy of Arts and Sciences and a member of both the Association of American University Presidents and the Council on Foreign Relations. He presently is the Chairman of the Board of the Federal Reserve Bank of New York. While Dean of the Law School he was President of the Association of American Law Schools, and he was the founding Chairman of the Board of NASD Dispute Resolution. President Sexton received a B.A. in History from Fordham College; an M.A. in Comparative Religion, and a Ph.D. in History of American Religion from Fordham University; and a J.D. magna cum laude from Harvard Law School. He is an author of the most widely used legal textbook on any subject, a text on Civil Procedure. He is also the author of *Redefining the Supreme Court's Role: A Theory of Managing the Federal Court System* (a treatment of the Supreme Court's case selection process), in addition to several other books, numerous chapters, articles, and Supreme Court briefs. Before coming to NYU, President Sexton served as Law Clerk to Chief Justice Warren Burger of the United States Supreme Court (1980-1981), and to Judges David Bazelon and Harold Leventhal of the United States Court of Appeals (1979-1980). For ten years (1983-1993), he served as Special Master Supervising Pretrial Proceedings in the Love Canal Litigation. From 1966 to 1973, he was a Professor of Religion at Saint Francis College in Brooklyn, where he was Department Chair from 1970 to 1975.

Greig Stewart, Executive Director of College Park Scholars at the University of Maryland. He assumed this position after having served as the Associate Dean for the University's Philip Merrill College of Journalism since 1987. He holds an affiliate faculty appointment with the Counseling and Personnel Services Program in Maryland's College of Education. Prior to his Maryland appointments, he held several student affairs positions at The American University and The Catholic University of America. Dr. Stewart's research interest is in community service. He has written and consulted on service learning and values development and was an inaugural dean of the State of Maryland Exchange, which links scholarship and community service. Dr. Stewart earned his bachelor's degree from the University of Massachusetts with a major in Sociology, his master's degree in Counseling and Student Personnel at the University of Maryland, and a Ph.D. in Counseling and Student Development from The American University. His teaching career began in North Africa, where he

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Marilla Svinicki, Associate Professor of Educational Psychology and Director of the Center for Teaching Effectiveness at the University of Texas at Austin. She received her B.A. and M.A. in Experimental Psychology from Western Michigan University and her Ph.D. from the University of Colorado. Prior to joining the UT Austin faculty 30 years ago, she taught at Macalester College in Minnesota. She has written and edited several books and articles on applying principles of learning and motivation to instruction at the postsecondary level. She has been the Editor-in-Chief of *New Directions for Teaching and Learning* since the early 1980s and continues to find new ways to stimulate the thinking of those in higher education about ways to improve teaching and learning through the application of research.

Robin S. Tanke, Associate Professor, Department of Chemistry at the University of Wisconsin at Stevens Point. She received her B.S. in Chemistry from the University of Notre Dame and received her Ph.D. in Organometallic Chemistry from Yale University. She was a NIH postdoctoral fellow with Charles Casey at the University of Wisconsin until 1992, when she went to Hoechst–Celanese Chemical Company doing catalyst development. Since 1998, she has taught general and organic chemistry at the University of Wisconsin-Stevens Point (UWSP). Her research has included the synthesis and characterization of organic, organometallic, inorganic, and nanoscale solid state materials. Her research interests in nanoscience have resulted in collaborations both in and out of UWSP and with physics and biology departments. She has also offered an undergraduate course on nanoscience. She is currently working with other UW comprehensives and the UW colleges to strengthen the undergraduate research program in the UW system.

Rebecca Thomas, Assistant Director of the Gemstone Program at the University of Maryland. The Gemstone Program is an undergraduate Honors program devoted to multidisciplinary team research. She earned her bachelor's degree from the University of Illinois, and master's degree from the University of Georgia, and is working on her Ph.D. in Higher Education from the University of Maryland. She has worked for the Gemstone Program since 2000.

Robert J. Thompson, Jr., Professor of Psychology, Dean of Trinity College of Arts and Sciences, and Vice Provost for Undergraduate Education at Duke University. He also holds appointments in the Departments of Psychiatry and Behavioral Sciences and Pediatrics. His research interests address how biological and psychosocial processes act together in development. His primary focus has been on the adaptation of children and their families to chronic illnesses and developmental problems, including cystic fibrosis, sickle cell disease, and very low birth weight infants. He has authored more than 100 scientific publications, including most recently the book *Adaptation to Chronic Childhood Illness*, and has served on the editorial board for several scientific journals and as Associate Editor for the *Journal of Pediatric Psychology*. He was President of the Association of Medical School Professors of Psychology from 1986 to 1988 and honored in 1993 with the Distinguished Researcher Award. He received the Distinguished Service Award of the Society of Pediatric Psychology in 1997. Long involved in undergraduate education, he served as Director of the Undergraduate Program in Human Development and Co-Director of the Faculty Associates before assuming his current positions. Dr Thompson holds a B.A. degree from LaSalle College and a Ph.D. in Clinical Psychology from the University of North Dakota. Prior to joining the Duke faculty, he held positions at Georgetown University Medical Center and The Catholic University of America.

Karan Watson, Dean of Faculties and Associate Provost and Regents Professor of Electrical Engineering at Texas A&M University. Her primary research interests are in change management, embedded computer systems, and engineering education. Dr. Watson has been the advisor for 25 Ph.D. graduates and more than 50 master-level graduates, and she has engaged and funded more than 300 undergraduates in research experiences in her research or with colleagues in the engineering program at Texas A&M. Her numerous honors include the IEEE Undergraduate Teaching Medal (1996), the HP/IEEE Harriett Rigas Award (1996), the U.S. President's Award in Engineering and Science for Mentoring Underrepresented Minorities and Women (1997), the ASEE Minority Award (1997), the American Association for the Advancement of Science Mentoring Award (1999), the Women in Engineering Programs Advocates Network Founders' Award (1999), and the Senior Fellowship of the National Academy of Engineers Council for the Advancement of the Science of Engineering Education (2003). She is a Fellow of IEEE and ASEE. She received her Ph.D., M.S., and B.S. in Electrical Engineering from Texas Tech University. She was previously employed as a communication engineer for AT&T Longlines and Hicks and Ragland Consulting Engineering.

Robert Weisbuch, President, The Woodrow Wilson National Fellowship Foundation and President Designate, Drew University. Since joining Woodrow Wilson in 1997, he has sought to make the implicit values of the Foundation's various fellowship programs more explicit through such initiatives as The Humanities at Work, which emphasizes the application of these disciplines to the public sphere, and The Responsive Ph.D., in which 14 universities have joined to attempt a more dynamic relation between high learning and the many spheres of academia and the world at large that employs doctoral graduates. Dr. Weisbuch, who has a Ph.D. in English from Yale University, spent 25 years at the University of Michigan as a professor of American literature, Chair of English, Associate Vice President for Research, and Interim Dean of the Graduate School. He also led an initiative to improve the undergraduate experience there. His publications include *Emily Dickinson's Poetry* and *Atlantic Double-Cross: Literary Relations between England and America in the Age of Emerson*, and more recent essays on Dickens, Emerson, Henry James, Melville, and Dickinson once again.

Carl Wieman, Distinguished Professor of Physics and a Fellow of JILA at the University of Colorado at Boulder. He received his B.S. from the Massachusetts Institute of Technology and his Ph.D. from Stanford University. He has carried out research in aspects of laser spectroscopy, including using laser light to cool atoms. This led to cooling atoms sufficiently to attain Bose-Einstein condensation in a vapor, for which he was awarded the Nobel Prize in Physics in 2001, as well as numerous other awards. He has worked on a variety of innovations in teaching physics to a broad range of students, including the Physics Education Technology Project, which creates online interactive simulations for learning physics (*www.colorado.edu/physics/phet*). He is a 2001 recipient of the NSF's Distinguished Teaching Scholar Award and a member of the the Board of Physics and Astronomy, the Committee on Undergraduate Science Education, the National Task Force on Undergraduate Physics, and the National Academy of Sciences. He is also Chair of the Board on Science Education at the National Academies.

Lee Willard, Associate Dean for Academic Planning and Special Projects, Arts and Sciences and Trinity College at Duke University. In this capacity, her major functions are academic planning, institutional proposal development, and programmatic development for Trinity College, Duke University's undergraduate liberal arts college. She has been involved in Arts and Sciences and the New Millennium (the Arts and Sciences Plan), Curriculum 2000 (the revision of the liberal arts undergraduate curriculum), the implementation of the East Campus residential plan, and the development of a series of institutional grants, ranging from the development of the first-year FOCUS Program, the Writing Program, and the Markets and Management certificate to undergraduate science education, women in science, and facilities planning and renovation. Dr. Willard holds a B.A. from Agnes Scott College and a Ph.D. in Classics from the University of North Carolina at Chapel Hill. She held a postdoctoral fellowship at the William Andrews Clark Library, UCLA, and is an alumna of Harvard University's Management Development Program (1996). She serves on the national advisory boards of the Reinvention Center and Project Kaleidoscope.

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Paul Woodruff, Darrel K. Royal Professor in Ethics and Director of the Plan II Honors Program at the University of Texas. Plan II is a selective honors program, based on a core curriculum in the arts and sciences, which itself constitutes an academic major. He has taught philosophy since 1973 and is a member of the Academy of Distinguished Teachers at UT. His specialty is ancient Greek philosophy. His books include a number of translations from ancient Greek, as well as a meditation entitled, *Reverence, Renewing a Forgotten Virtue*, which seeks to present an ancient concept for use today. He has participated in a number of collaborative projects with other scholars. Dr. Woodruff received his B.A from Oxford University and his Ph.D. from Princeton University.

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