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Incorporating TQM and CQI techniques into evaluation tools for the electrical and computer engineering learning communities

by

Richard Wayne Freeman

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Computer Engineering

Program of Study Committee:
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Ames, Iowa

2004

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For the Major Program

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1 INTRODUCTION

The Computer Engineering Learning Teams (CELTS) and Electrical Engineering Learning Community (EELC) are the two Learning Communities within the Department of Electrical and Computer Engineering (ECPE), and two of the nearly 50 Learning Communities available to First Year students at Iowa State University. Both these Learning Communities are designed to help First Year students make the transition from high school to college, learn about Computer or Electrical Engineering, build connections with either Electrical or Computer Engineering, and retain them in either Electrical or Computer Engineering.

Both of these learning communities have very good student reactions to the learning community experience. While student reactions are favorable, neither learning community has an assessment plan that explores how well it is achieving its learning outcomes, the effectiveness of important learning community elements, student satisfaction, or long-term effectiveness. [1] This dissertation outlines an assessment tool that will improve the data gather for both learning communities.

Learning Community Basics

Learning communities are a concept that has existed, and been practiced, for many years. Since communities are normally viewed as groups of people that share some geographic, religious, professional, or common interests or identities, the thought of a community as a mechanism for teaching and learning, within an educational setting, seems strange. Prospective students and their families usually react positively when the concept is explained, with education, as the common interest. The term is used in multiple contexts

today- describing learning communities as a single classroom or course, residence hall program, student-type or interest group, a thematic course of study, or virtual learning environment. [2,3] According to Lenning and Ebbers, learning communities are "an intentionally developed community that will promote and maximize learning". [4]

Learning Communities at Iowa State University

The evolution of learning communities, at Iowa State University, started in 1994. In the 2002- 03 Academic Year, learning communities at Iowa State attracted 1,654 students, which represents 39.6% of the first year students. [5] An additional 485 students, identified as other than first year students, participated as well. Approximately 60.6% of first year engineering students participate in at least one learning community. [6]

Iowa State University, through its learning community initiative, has several subcommittees that enable learning community activities. These subcommittees include- Assessment, Curriculum Development and Enhancement, Peer Mentors, and Institute. The subcommittees focus on tasks necessary to create, maintain, and disseminate information about learning communities at Iowa State. Through these subcommittees, and links to key Iowa State University departments and offices, the learning community initiative can support multiple models.

Iowa State University supports several models of learning communities- Course Clustering, Course Links, Enhanced Course Links, and Enhanced Course Links with Seminar. [7] In addition, Student-Type and Residential Option models exist, but as enhancements to other models. Each model will be discussed.

Course Clustering

Cohorts of students are scheduled into the same sections of courses. The courses themselves have no links. The faculty members teaching these courses may not know that learning community students are scheduled in their sections. Several learning communities use this model to give their cohorts a common set of courses. Sections of required courses, like English 104/105, Chemistry 155/165/167/177/178, and Math 165/166/265/267 typically are setup so no more than half of any class section (usually 15 students) can be reserved for learning community students. Students participating in a learning community cohort can register early for their learning community assigned classes. This early registration allows unreserved seats to be released to students not participating in a learning community, but still needing that particular class.

Course Links

Cohorts of students are scheduled into two or more courses. The instructors in the courses share syllabi, but there is no effort to incorporate material from both courses. An example of this is a learning community that includes English 104/105. Students will be enrolled in at least one other course and English. The English Department (or faculty) know there is a cohort from a learning community, and might assign papers based on that other course, but since English is a basic requirement for all students at Iowa State University, there is no real effort to include subject matter from the other courses.

Enhanced Course Links

In this structure, courses are better linked than the Course Links structure. The instructors not only share syllabi, but work to incorporate subject matter, and hold class visits. An example of this is learning community that incorporates subject matter from the major and includes English and/or Mathematics. Students can be exposed to new concepts in one class, and write about them in English. Another possibility is to incorporate Mathematics- using the Mathematics course to introduce a Mathematical concept that is then put in context of the cohort's major- for example, introducing students to Integrals in Calculus II, then having them use various Integration techniques to solve AC Step and Natural Response Circuit problems.

Enhanced Course Links with Seminar

In this structure, student cohorts are enrolled in two or more courses, plus a seminar. The courses are linked. Subject matter is shared, and class visits occur. The major difference is that team teaming may be a part of the structure, and the learning community may be thematic in nature. Using the example from the Enhanced Course Links structure, students in this type of learning community might have their Mathematics instructor attend, and teach, the required Mathematics skills during their Circuits course; then have their Circuits instructor teaching and attending some of their Mathematics classes.

Residential Options

The Residential Learning Community is another model. This model was designed to take advantage of students living in close proximity to one another. According to Lenning and Ebbers, studies have shown that residential learning communities, that do not have an academic component, do not increase student learning.[8] The best use of learning communities in a residential setting, is to include an academic component. At Iowa State University, learning communities may or may not have a residential component. "Living/Learning Option" is the designation for communities that are linked with the Department of Residence by a residential component. The residential option allows student cohorts to live together (up to half a resident hall house (30 students)) in the same house. These learning teams also have Peer Mentors who live with the cohorts, and work with the Resident Assistant, to provide additional support and guidance outside the classroom. The Department of Residence has been accommodating of Learning Communities. Resident Assistants and Peer Mentors attend joint training the week prior to the beginning of the Fall Semester. The Department of Residence staff (usually Hall Advisors meet with the learning community Peer Mentors and Resident Assistants regularly to discuss any concerns or issues that may arise in a house.

Student-Type

In addition to Residential Learning Communities, Lenning and Ebbers also describe the Student-type Learning Model. This model is designed for students from special populations. These populations have been defined as:

- The academically under-prepared
- Underrepresented groups
- Students with disabilities
- Honors students
- Students with specific Academic interests [9]

This model takes advantage of the knowledge that students of similar backgrounds and/or student type tend to socialize and study together. Involvement Theory has been one of the key factors in the creation of student-type learning communities. Involvement theory suggests that student involvement with faculty, staff, institution, and students adds to positive student bonding, retention, and academic success. [10] Learning communities such as AMES (Agricultural Minorities Encourage Success), LEAD (Leadership through Engineering Academic Diversity), Women Engineering, and WiSE (Women in Science and Engineering) are examples of learning communities that are student-type based on both ethicity and/or gender, and academic interest. Both EELC and CELTS, by this definition, are Student-Type with Class Clustering.

Factors affecting Learning Communities and ECPE

Increased "learning productivity" has had appeal for college and university administrators as well. Public colleges and universities have had to contend not just with increased scrutiny, in the form of assessment, but also decreased public funding. Federal and State funding, as a percentage of revenue, has decreased every year (1997 – 2002) to Iowa State University. [11] During the same period, enrollment increased every year. Faculty headcount and Full-Time Equivalents (FTEs) during that same period decreased. In Research One Institutions, there has also been additional pressure on faculty to secure research grants. With increased research responsibilities, faculty members have been able to

"buy out" of teaching. This puts additional pressure on the rest of the faculty. In particular, the Department of Electrical and Computer Engineering saw increasing enrollments. Faced with serious pressures, colleges and universities, like Iowa State University have had to increase class size, add additional sections, and/or increase faculty teaching loads.

In addition to internal practices, and external pressures, Iowa State University included learning communities as a key element in its strategy to improve undergraduate education. The 1995- 2000 Strategic Plan recognized the need to support learning communities, with it, a goal of increasing support. [12] This promise of increased support did not materialize. As a result, the spread of learning communities throughout the institution was slower than expected.

Assessment within the Learning Community Initiative

Even though learning community growth has been slower than planned, the effects of having them have been felt. The Learning Community Assessment Subcommittee conducts university-wide assessment and provides assessment information on the Learning Community Initiative for Iowa State University. This group has several goals that it attempts to meet annually: "conduct campus-wide Learning Community assessment, develop an approach to strengthening individual Learning Community assessment, provide consultation to individual Learning Communities, and attempt to identify successful components of the Learning Community experience." [13] Several activities by this group support the goals. The campus-wide assessment includes what the Subcommittee refers to as "accountability dimensions" (participation rates, retention, and grade point average), as well as surveys that attempt to uncover student attitudes and habits.

Retention and Academic Success

Participation in Learning Communities has lead to an increase in student retention. The retention rate for first year students participating in Learning Communities is higher than students who choose not to participate. Even when adjusting for High School Rank and ACT scores (two factors often seen as predictors of student retention and success), there is still a statistically significant difference between students who participate and do not participate in Learning Communities. [14] In fact, there is a statistically significant difference in retention for First through Fourth Year students. The retention of students equates to an additional $1.6 Million to Iowa State University. [15]

There are also differences in academic success, as measured using grade point average. The first semester grade point averages for participants in Learning Communities are higher than those of students who do not participate in Learning Communities.[16] The difference in grade point average persists as students are enrolled in additional semesters. The effects of Learning Community participation appear to persist through graduation. [17]

Assessment Subcommittee Survey Findings

The surveys administered by the Assessment Subcommittee uncover student attitudes and habits. The surveys were used to attempt to uncover student attitudes and the Learning Community elements that might account for the differences in grade point average and retention. The ISU Undergraduate Education Survey revealed several things about student attitudes. In comparison to non-participants, Learning Community students strongly agreed with statements:

- I was able to earn higher grades in classes
- My professors had high expectations for me
- I better understand the nature of my major
- I have had experiences that "fit together" in helping meet goals as a student
- I have received prompt feedback about progress in classes
- I was able to see connections among classes
- I was able to see connections between personal experiences and class learning

In comparison to non-participants, Learning Community students were more satisfied with:

- opportunities to interact closely with faculty
- level of individual support, encouragement from faculty
- opportunities to participate in a department club, resident government, or other organization
- opportunities to develop or participate in study groups
- opportunities to apply learning to real-world problems
- opportunities to practice skills
- overall quality of classmates
- overall experiences at ISU
- opportunities to interact with people from different cultural backgrounds [18]

Lastly, Learning Community participants reported spending significantly more time studying in groups and performing community service/volunteer work.

The National Survey of Student Engagement (NSSE), is a survey designed to measure student engagement in educational practices that promote learning. These practices are time on task, active learning, and contact/collaboration/cooperation.[19] The survey reported that Learning Community participants were more likely to:

- work with classmates outside of class
- tutor or teach other students
- write papers between 5 and 19 pages in length
- participate in a community-based projects as part of a course
- talk about career plans with a faculty member or advisor
- work with faculty members on activities other than coursework
- report positive relationships with faculty members

- report that ISU has helped them learn to analyze quantitative problems [20]

Lastly, the Assessment Subcommittee administers the ISU Expanded Retention and Academic Performance Study. This survey attempts to uncover the characteristics of teams that account for the above findings. The survey treats grade point average, retention, and participant satisfaction as dependent variables. Best practices, Interactive/Communicative Activities with others, and Available and Active Advisers were three factors that held reliable across all cohorts of Learning Community participants. This survey validated data from the other two surveys by identifying a majority of the previously listed activities (from the NSSE Survey) and reasons for participant satisfaction (from the ISU Undergraduate Education Survey), as Best Practices and Interactive/Communicative Activities with others. Having a helpful advisor, and an available advisor were two items identified for the Active Adviser factor. [21]

Participants also were given the opportunity to self-assess their skills after the Learning Community experiences. Students identified study skills/time management, written communication, oral communication, critical thinking/problem solving, knowledge of discipline, career choices, and university resources as skills they gained through their participation in the learning community experience. [22] These skills, combined with the behaviors and attitudes expressed in the surveys indicate that the students benefited greatly from participating in Learning Communities. The lists of skills due to, and reasons for, positive Learning Community experiences, match many of the outcomes that educational reformers are looking to infuse into all engineering institutions. [23] Chapter 2 includes an

overview of these outcomes and potential vehicles for delivering change to engineering education institutions.

The effects of Learning Communities, at Iowa State University, have not gone unnoticed. US News and World Report ranked Iowa State University's Learning Communities as the fifth best in the nation. [24] In addition, a recent consultant's report praised the Learning Community initiative, noting strengths like assessment (for accountability and analysis), infrastructure, support for university leadership, incentives and rewards (in particular, the Promotions and Tenure guidelines including scholarship of teaching and learning), and Peer Mentors. [25] The report also outlined several areas for improvement. Like the Assessment Subcommittee, the consultants noted that individual Learning Community assessment was very important for continuing the evolution of Learning Communities at Iowa State. [26] The consultants cited strong institutional-wide assessment of Learning Communities, and suggested that additional assessment be done for individual communities- "work at understanding more clearly what happens at the level of individual learning community programs." [27] The recommendation calls for formative assessment and assessment for improvement.

CELTS and EELC Structures

Both CELTS and EELC use course clustering. Students participating in one of the learning communities are scheduled into a learning community section. The learning community section has a specific section of Mathematics (typically Calculus I and II), Science (Chemistry in the Fall Semester and Classical Physics I in the Spring Semester), and a section of the learning community course (Engineering Problem Solving and

Programming). CELTS has the Living/Learning Option, but does not require students in the cohorts to live in one of the CELTS houses. EELC does not have the Living/Learning Option. Both learning communities have Peer Mentors that are usually chosen from previous learning community cohorts. These Peer Mentors work as additional Teaching Assistants in laboratory sections, social coordinators for activities, study group leaders for study groups, and mentors for class scheduling and overall university questions.

Both learning communities engage in strong use of classroom assessment techniques but little formative or summative assessment. Assessment is a means of determining how well programs are achieving their desired goals. In the case of these two learning communities, assessment can also provide useful feedback for improvement and data for future uses. How well these two learning communities are performing, and can perform, can only be established by performing assessment.

Definitions

Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning. [28] Assessment and evaluation are often used interchangeably. By using the above definition for assessment, then evaluation is defined as the meaning or interpretation of the data gathered from assessment activities. [29]

Formative Assessment is assessment conducted for the purpose of improving a process or program. Formative assessment can be both informal and continuous in nature. This assessment allows for corrective change to a program while it operates. This can be in the form of mid-semester assessments. The audience for the results are usually different than that of the summative assessment. Typically, the audience is within the department, or the faculty member teaching the course. [30]

Summative Assessment is assessment conducted for the purpose of making a final judgment about the effective of a program or process. The audience for the results is usually decision-makers and stakeholders. In terms of an educational setting, the audience might be administrators outside the department or college, and/or those responsible for accreditation. [31]

Performance Indicators, or Performance Measures, are a way of telling someone something about what you are doing, whether it works, and what your plans are for improvement. Performance Indicators can result from assessment. These indicators are based on answering specific questions, and change as the questions change. [32]

Gap Analysis is part of the Total Quality Management (TQM), Continuous Quality Improvement (CQI) and ISO 9000 processes. When using Gap Analysis, the evaluation team must define (quantify) the present state, define the desired state, and the gap between the two. If the gap is statistically significant, then closing that gap may improve the quality of produces/services being delivered. [33]

Continuous Quality Improvement (CQI) is a cyclical process of review that shifts the focus from the end product or service, to the process. [34] In education, the focus shifts from the end product (graduation and retention), to the process (students learning). By examining what and how students are learning, the educational institution, departments, and faculty can then try new instructional methods to improve student learning. The improvement in student learning should lead to improved retention, graduation, and more capable graduates.

Total Quality Management (TQM) is described both as "a philosophy of continuous improvement", and a description of the "tools and techniques which are used to put quality improvement into action." [35] TQM is a strategic management approach that focuses on the needs of the organization's customers and clients.

Stakeholders are individuals or groups that have a stake in, or may be affected by the program to be assessed. [36]

Outcomes are the talents and skills that the educational program is attempting to develop within its students. [37]

Inputs are the personal qualities students bring to the educational program. These qualities include initial level of developed talent. [38]

Environment refers to the actual student experiences during the educational program. The environment is especially important because it includes things over which the faculty has direct control. [39]

External Customers are stakeholders outside of the educational institution.[40] Employers, parents, legislators, faculty at other institutions, and others are external customers.

Internal customers are stakeholders inside of the educational institution.[41] Faculty that teach foundation courses have faculty that teach the successive courses as internal customers.

Next-in-line Analysis is a method of helping staff identify their direct customers by answering two questions.[42] Next-in-line Analysis allows staff to develop a customer focus.

2 Literature Review

Assessments, and the pressures to assess educational programs, have been growing for more than twenty years. Figure 1 is a Force Diagram of external and internal forces pressuring for higher education to engage in some sort of summative assessment. These initial efforts were started during the 1980s, as part of a movement to hold public institutions accountable. [43] "Approximately two-thirds of states had developed assessment mandates by 1990- established either through legislation or state agency regulation, and requiring all public colleges and university institutions establish local, campus-based approaches to assessing and reporting student performance." [44] As of 1998, eighteen to twenty states had also developed measures of institutional performance. [45]

The ideas of Process re-engineering and Continuous Improvement were repackaged and called "Reinventing Government". In industry, these ideas were credited were reducing overhead and redundancy, thus leading to more efficient operations that were characterized by lower costs. According to McGuinness, "reinventing government ", applied to public colleges and universities, meant outcomes were being monitored more closely. Those in charge of overseeing these institutions were expecting increased "learning productivity." [46]

States have not been the only governmental bodies seeking to assess and measure the performance of higher education institutions. By law, colleges and universities must report their graduation rates to the United States Department of Education's National Center for

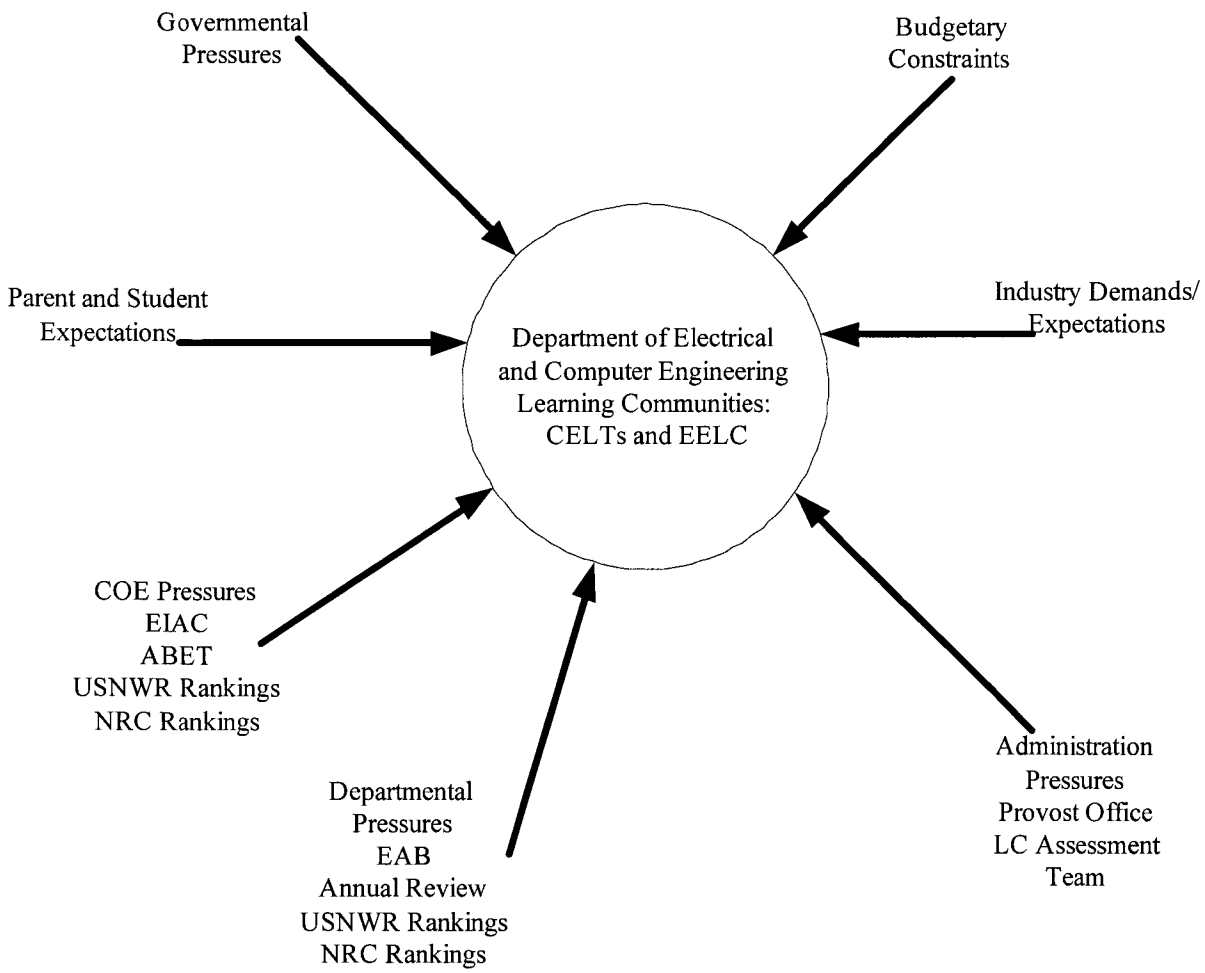

Figure 1: Force Diagram

Education Statistics. This same data also has to be made public upon request. The Department of Education does not use that data to evaluate institutions, nor are institutions required to track student retention rates, but in 2002, the Bush Administration proposed such an evaluation plan. As part of the Administration's higher-education policy, a section on improving accountability was included to outline the Administration's attempts to monitor graduation rates and "hold down college costs". [47] The policies were targeted not just at public institutions, but private higher-education institutions as well. The Bush Administration's draft policies mandated that states collect college graduation and retention data for evaluation purposes. [48]

The effort is not the first attempt- The Clinton Administration created the State Post-secondary Review Entities, which were to be state-oversight agencies.[49] Congress mandated these entities in 1992. Their role was to "ensure that colleges (public and private) and trade schools were educating students and properly handling federal student-aid funds." [50] These agencies were repealed in 1995. The efforts of both the Bush and Clinton Administrations led to organized resistance by higher education associations, institutions, and the States. In response to the proposed changes, Terry W Hartle stated, "the quality of higher education is the responsibility of institutions [and] accrediting agencies, and for public institutions, [it's also] state governments, and this approach has served the nation well." [51]

The Bush draft policies were particularly disturbing to the Higher Education Community. The policies went further than just mandating performance evaluations. The Bush policies included examining retention policies and finding "ways to use federal money in an incentive fashion to reward programs that work." [52] In addition, the draft policies

were to examine the role of accreditation. The new policy was to be focused at ensuring that accreditation, and the accreditation process, was not just about "counting books, or how many faculty members institutions have." [53]

Traditional not-for-profit higher education institutions are also viewing the draft policies as a move that favors nontraditional for-profit institutions.[54] These newer institutions seem better at student retention, flexibility, and attracting nontraditional students and those seeking continuing education opportunities.

As more graduates have entered the workforce, industry has been able to give feedback on the quality of those graduates. The knowledge, and more importantly, the *abilities* of these new hires has allowed companies to comment on their new employees preparation for entering the workforce, and indirectly, on the quality of degree-granting programs that have certified, via the degree, those new employees preparedness for serving as Engineers.[55] The creation of external advisory boards, populated with industry executives, managers, and practicing engineers as led to industry having a direct line of communication to an institution. This feedback has led to serious discussions of how students are being prepared for a career in industry, and direct feedback on curricula decisions.

For engineering faculty, ABET is viewed as a major initiator of the drive for assessment. While some may believe this to be true, this is not the case. ABET has been responding to the same forces. The Accreditation Board for Engineering and Technology (ABET) is the accrediting organization for post-secondary programs in applied science,

computer science, engineering, and technology, in the United States. [56] ABET is a federation of the thirty-one technical and profession societies that represent the technical and professional fields for which ABET performs accreditation. ABET's Vision is to "provide world leadership in assuring quality and in stimulating innovation in applied science, computing, engineering, and technology education." [57] As part of its mission, ABET will:

- Accredit educational programs
- Promote quality and innovation in education
- Consult and assist in the development and advancement of education worldwide in a financially self-sustaining manner
- Communicate with our constituencies and the public regarding activities and accomplishments
- Anticipate and prepare for the changing environment and the future needs of constituencies
- Manage the operations and resources to be effective and fiscally responsible. [58]

ABET accreditation does not imply there is uniformity in how standards are met across engineering educational programs, but it does imply that the standards are met. This has allowed programs to evolve unique methods of educating engineers that meet ABET standards.

According to ABET, accreditation in the United States is a voluntary, non-governmental, peer-reviewed process. While no engineering educational program within an institution has to apply for accreditation, receiving ABET accreditation ensures that the educational program has met standards or criteria as defined for that profession. Furthermore, accreditation, and the accreditation process, allows the Deans, Faculty, and Administration to uncover the strengths and weaknesses of educational programs seeking accreditation. Parents and prospective students will know whether an educational program

meets the current minimum standards. Employers will know whether program graduates are prepared to work as Engineers. Some states, like Iowa, require all applicants, for professional licensure, to submit a college transcript showing satisfactory completion, or near completion, of work from ABET-accredited educational program. [59] Other states, like Maryland, will allow applicants to apply for licenses without completing a degree from an ABET-accredited institution, but the applicant must submit transcripts and supporting information that can be used to prove the institution's program meets that state's requirements. Lastly, ABET accreditation signals taxpayers and legislators that the educational programs are educating graduates that are employable, and ready to serve the public responsibly. [60]

ABET has provided accreditation services for more than seventy years.[61] Even ABET has been subject to pressures. In the 1980s and 1990s, a series of reports from The American Society of Engineering Education (ASEE), ASEE Engineering Deans Council, National Science Foundation (NSF), and National Academy Of Engineering's National Research Council (NRC) all recommended major changes and reforms to engineering education. To this end, the National Academy of Engineering (NAE) began funding major initiatives to foster reform. Engineer of 2020, Information Technology in Engineering Education, and a Center of Scholarship in Engineering Education are three major NAE initiatives designed to study changes in the Engineering profession, predict the necessary skills required by future Engineers, and plan educational changes required to meet future needs. [62]

The NSF also began funding the Engineering Education Coalitions Program. This

program funded consortia of engineering colleges. Each of these consortia is a mix of colleges- ranging from Research One to predominantly undergraduate institutions. Their goal is to "redesign curricula and improve teaching methodologies." [63] Funded coalitions like SUCCEED, FOUNDATION, SYNTHESIS, and ESCEL, are also heavily involved in dissemination of the results. [64, 65, 66, 145] In 1995, major changes were initiated to change accreditation criteria so as not to hinder programs from implementing educational reforms.

Part of the influence on ABET has been the realization that the learning process is very complex, and the current educational paradigm do not address this fact. Work done in Educational Psychology, and how the brain learns is impacting how the world views the educational process. Additional work has resulted in numerous instructional theories. In particular, two teaching paradigms have come to dominate the discussion of how to educate students. According to Johnson, Johnson, and Smith, the two paradigms can be described using five facets- knowledge, students, faculty purpose, relationships, context, and assumption. [67]

The Teaching-Centered Paradigm places the Professor in the role of subject-matter expert, whose job it is to transmit the knowledge, and student in the role of novice, whose job it is to absorb the transmitted knowledge.[68] The student is then expected to be able to recall and apply the knowledge. In this paradigm, testing can be very simple in terms of complexity, yet very difficult. Critics of the Teaching-Centered Paradigm often point to the examples of students that received As in a course, yet cannot apply or recall that same knowledge after the class has ended.

Students are passive in the learning process. The analogy is that of students as empty vessels waiting to be filled with knowledge. Students are seen as passive in the process. The professors are owners of the knowledge with which they fill the students. In this type of classroom, students are sitting quietly, taking notes and absorbing the knowledge and *meaning of that knowledge*.[69]

The faculty purpose is to sort and classify students. This classification is done by determining who gets which grade.[70] The sorting is done by deciding who does and does not meet graduation requirements. In this course, there is a pre-determined grade distribution. Students are essentially competing against each other for a grade. The success of one student might mean the failure of another.

The relationships between student, and faculty and students are impersonal. In Research One Institutions, we often see these types of student/student and faculty/student relationships. Boyer noted that institutions would tout their faculty research awards, and give these same faculty members the option of not teaching undergraduate students, or insulate them from these students via teaching assistants that answer questions, prepare and grade tests, and effectively teach the courses. [71] Johnson, Johnson, and Smith attribute this mindset to the Taylor Model of Industrial Organizations. In this model, students and faculty can easily be replaced- much like parts in a machine. [72]

The educational context is competitive. "Cream rises to the top," is a saying that many faculty members have used- referring to students. Many engineering graduates recall

someone, sometime during their first week at college, saying, "Look to your left, look to your right, two of you will not be here for graduation." [73] Given the faculty purpose- to "weed out" those who are not capable of being Engineers, the context is one that forces students not to cooperate.

The Paradigm operates under the assumption that anyone who is an expert in a given field can teach without training. [74] This assumption relies on the belief the teaching is easy, and does not require any special skills or training beyond earning a PhD. Many institutions hire new faculty based on their research credentials, not teaching abilities. In classrooms with brand new PhDs hired and assigned classes, without any preparation.

In the Learner-Centered Paradigm, the professor is the facilitator, whose job it is to create the environment where students create and construct meaning. [75] Constructivism is at the heart of this paradigm. Constructivism is learning philosophy based on the idea that people create (construct) meaning and understanding by filtering new information through our past experiences and understanding. "Learning therefore is simply the process of adjusting our mental models to accommodate new experiences." [76] The faculty guide students to construct new knowledge.

Students are active in the learning process. Faculty members are facilitators of the learning experience. In this type of classroom, there is activity- students are actively engaged in conversations, discovering the knowledge and constructing the *meaning of that knowledge*. Faculty members are checking what is being constructed, and often redirecting the process through questioning and engaging the students in activities.

The faculty purpose is to help students develop competencies and talents. The purpose is to help students sharpen their abilities. Student abilities are seen as dynamic and "always susceptible to change." [77] Unlike the sorting and classification purpose, in the old paradigm, the faculty help students understand the connection between effort and achievement.

The educational process is a personal transaction between faculty and students, and students and students. "Learning is a personal but social process that results when individuals cooperate to construct shared understandings and knowledge." [78] Students encourage and push each other to learn. Professors create the environment for students to work together.

For students to work together, the educational context has to be cooperative. The competitive environment discourages students from working and learning together. In a cooperative environment, students are encouraged to learn and work together. The cooperative environment is essential to creating the environment where the above facets can exist. Group work does not have to equate to group grades. Students "riding others coattails" is often cited as a reason for faculty not to foster a cooperative environment. [79] There are numerous ways of including individual accountability and grading into this context.

Lastly, teaching is viewed as a complex activity that requires extensive training. Unlike the Teaching-Centered Paradigm, the Learner-Centered Paradigm assumes that teaching is an application of theory and research. To be an effective teacher in the paradigm, Professors need intensive training and continuous honing of their teaching skills. [80] To

make this happen, faculty members have to be committed to continuous learning, as well as open to peer review. In this paradigm, students that have the requisite skills for engineering work are more likely to be retained because they would be actively engaged in a learning process that valued their abilities while continuing to help them improve and learn.

The argument for educational reform was captured in a series of conferences and reports. Those advocating reform point out that Engineering Education has not kept pace with the changes in engineering practice, and how technology is evolving. Advocates are pushing for engineering education to move away from increasing science and mathematics requirements, and instead broadening the curriculum to help students gain a larger perspective of the true role of engineering in the world. [81, 82, 83] The argument points to globalization and global competition, the use of Information Technology, and how technological innovation has changed.

Wulf declares, "Science is analytic- it strives to understand nature, what is. Engineering is synthetic- it strives to create what can be. Engineering is creating, designing what can be, but it is constrained by nature, cost, by concerns of safety, reliability, environmental impact, manufacturability, maintainability, and many other such 'ilities.'"[84] Engineering as a synthetic process is one explanation for how the engineering practice and technological innovation have changed. Jackson points out, "In today's environment, innovation and technological breakthroughs more likely are driven by convergence — where disciplines intersect. The sciences and engineering are becoming less separate and distinct from each other. They are blurring, as once singular fields now collaborate, with sometimes surprising, and always interesting, results." [85] Biotechnology, Nanotechnology, and

Biological Computing are examples of innovations that have been the convergence of disciplines. This convergence means Engineers are going to have to work in collaborative, multidisciplinary teams. Those teams may be comprised of individuals at multiple locations that are geographically dispersed. Information Technology has made this possible. The ability to share data, and interact through email, teleconferencing, and video teleconferencing, has allowed teams to draw members from wherever the technology allows.

The new Engineering Education Paradigm is characterized by many attributes. Splitt lists them as:

- Encouragement of diverse student academic backgrounds and faculty dedicated to developing emerging professionals;
- Connection of solid mathematics and scientific knowledge foundation with engineering practices;
- Maintenance of regular, well-planned interaction with industry-including industry-based projects;
- Emphasis on inquiry-based learning and preparation for lifelong learning, with much less dependence on lectures;
- Stress on integrative, systems thinking, coping with change, communications skills (listening, speaking, reading, and writing), teamwork and group problem-solving skills (from identification through analysis and resolution);
- Focus on design issues involving life-cycle economics, environmental impact, sustainable development, ethics, timeliness, quality, health & safety, manufacturability, social, legal, standards and ad hoc concerns. [86]

The benefit is institutions with programs exhibiting these attributes would be offering excellent engineering education opportunities for their students. These engineers would be ready to face an uncertain future with confidence. "This excellence in engineering education would be manifested in instruction, mentoring, role modeling, and guidance that reflect the attributes of the new paradigm, wherein emphasis is placed on communications and leadership skill development, teamwork and close interaction, systems thinking, eco-efficient

design, and lifelong learning- learning what to learn and how to learn it." [87] Noam and Splitt both recognized the emerging competitive pressures from for-profit institutions. [88,89] Noam was very clear in his assessment of how educational reform can help traditional institutions maintain their competitive edge, "The strength of the future physical university lies less in pure information and more in college as a community; less in wholesale lecture, and more in individual tutorial; less in Cyber-U and more in Goodbye-Mr.-Chips College." [90] The education reformers are looking for educational programs to actively engage students in the learning process, and change that process so these same students have a clearer understanding of the relevance of engineering in the world. ASEE, in its October 1994 report entitled *Engineering Education for a Changing World*, stated that:

> Engineering education programs must not only teach the fundamentals of engineering theory, experimentation and practice, but be RELEVANT, ATTRACTIVE and CONNECTED:
>
> REVELANT to the lives of and careers of students, preparing them for a broad range of careers, as well as for lifelong learning involving both formal programs and hands-on experience;
>
> ATTRACTIVE so that the excitement and intellectual content of engineering will attract highly talented students with a wider variety of backgrounds and career interests- particularly women, underrepresented minorities and the disabled- and will empower them to succeed;
>
> CONNECTED to the needs and issues of the broader community through integrated activities with other parts of the educational system, industry and government. [91]

The same reform-minded forces forged the ABET EC2000 Criteria. The ABET Accreditation process is credited with transforming engineering education in the 1950s, and advocates of change predicted that changes in that same process will again change the education process.[92] The EC2000 Criteria is outcomes assessment for educational programs. The Criteria is actual eight criteria- Students, Program Educational Objectives,

Program Outcomes and Assessment, Professional Component, Faculty, Facilities, Institutional Support and Financial Resources, and Program Criteria.[93] The Criteria receiving the most attention (as noted in publication), is Program Outcomes and Assessment.

Program Outcomes and Assessment (Criteria 3) has eleven outcomes that program graduates must demonstrate:

- an ability to apply knowledge of mathematics, science and engineering
- an ability to design and conduct experiment, 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. [94]

Educational programs seeking accreditation must demonstrate students and new graduates (within the last five years) have met these outcomes through assessment. "Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and objectives of the program, including those listed above, are being measured." [95] In other words, ABET performs assessment on a minimum of eleven outcomes, under Criteria 3, and a maximum as defined by the program, or institution, seeking accreditation. ABET allows programs to include student portfolios, placement data, student and alumni surveys, nationally-normed

subject content examinations (such as the FE Exam), and employer surveys as evidence of the program's success in, or improvement toward, meeting its program educational outcomes. [96]

These external forces have put exceptional pressure on colleges, departments and programs to provide meaningful assessment. In the pre-EC2000 environment, assessment had not been a priority, faculty had been accustomed to end of semester course evaluations, and therefore, many faculty members are not comfortable with the idea of assessment. In fact, many are struggling with a definition of assessment.

Chapter One provides a definition of assessment, but not some of the reasons for the discomfort with assessment. There are three general reasons to assess any project or program- to improve the program or project; to inform stakeholders whether the program, or project, is achieving it's goals; or to prove a program, or project is meeting, or has met its intended goals. [97] Assessment is usually seen, as an activity that is heaped upon the faculty- an administrative endeavor the faculty must endure. These types of assessments are usually Accreditation visits and Program Reviews. The faculty is these cases do not feel that they are in control of the processes, or have any real access to the data generated. These activities are usually in the context of reporting for some sort of accountability to governmental bodies (compliance), accreditation boards (program integrity and quality), and marketplace (competitive advantage). [98]

U.S. News and World Report also produces annual rankings. How the magazine computes and ranks institutions is not always known, and the criteria changes annually. The

faculties of the institutions, colleges and departments have little or no input into the process, yet some institutions seek to improve their ranking. This exercise requires institutions to guess what criteria has the most weight, and then move toward those measures. Since the criteria can change yearly, this effort

Another factor affecting faculty attitudes towards assessment is what is assessed. For assessment to be performed at all levels- institution, program (department), and course, the process should be the same, but the focus changes. This change in focus relates to the stakeholders are for that assessment report. The faculty is not usually included as a stakeholder group. [99]

Ewell points out "the assessment of student learning has become an essential operating requirement for colleges and universities." [100] Ewell contends that this assessment is needed to satisfy accountability to societal stakeholders and ensure program integrity. Coupled with the ABET EC2000 Criteria, which invites departments and faculty to determine what is assessed and how, faculty can longer avoid learning how to perform assessment. NSF-sponsored coalitions and ASEE offer annual workshops on assessment. These workshops are targeted toward helping faculty learn how to perform assessment, and hone their skills.

The question that still remains for many faculty members is "What is assessment, and why do I have to do it?" Angelo articulated a comprehensive view of assessment in higher education. Angelo asserts that:

> Assessment is an ongoing process aimed at understanding and improving student learning. It involves making our expectations explicit and public; setting appropriate criteria and high standards for learning quality; systematically gathering, analyzing, and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain, and improve performance. When it is embedded effectively within larger institutional systems, assessment can help us focus our collective attention, examine our assumptions, and create a shared academic culture dedicated to assuring and improving the quality of higher education.
>
> It is unnecessary to assess the performance of each student to know if engineering graduates from a particular program are generally developing the attributes of an ideal engineering graduate. Stated another way, we should not confuse the ability of the engineering education community to articulate a vision for the ideal graduate as a mandate for every graduate of every engineering program to demonstrate competence and proficiency in every attribute. Each goal is a yardstick against which to measure program success, not an item on a check list to inventory failure. Nor does program assessment measure just the outcome of an education (so-called outcomes assessment). It also examines policies, programs and other factors that influence the achievement of those outcomes. [101]

Angelo makes a distinction between assessment and outcomes assessment. Outcomes assessment is akin to the types of general program evaluations that have traditionally been carried out in education. That assessment is more comprehensive suggests that it can be used to provide information to transform a program.

The types of assessment that faculty members have traditionally engaged in used tests, quizzes, and some projects. While the this type of assessment allowed faculty members to determine how well students learned certain material, it did not uncover how students learned the material, whether that learning was just surface or deep learning, and whether students truly understood the material. In addition, the assessment method did not uncover how well the professors, teaching the classes, or what they could have done to improve student learning. The Teaching-Centered Paradigm places responsibility for learning on the

learner- the professor meets her responsibility by lecturing, assigning coursework, and testing. This assessment process may include a class or departmental survey at the end of the semester, but this survey usually has little or no bearing on how the professor teaches the class in the future.

Assessment may use tests, quizzes, and projects as direct measures of assessment, but will also use indirect measures of assessment (such as surveys and Classroom Assessment Techniques). Additionally, assessment may incorporate performance. Performance Assessment, or Authentic Assessment, measures student abilities by having the students perform the skills they learned in the program or course. If a course is to teach Digital Design, then having students solve a problem by designing a digital system is an example of performance assessment. The use of multiple methods allows the faculty to better uncover what students understand, as well as how the faculty can change their teaching methods to improve student learning. In addition, real assessment is a multi-step process that is integrated into the course, and is used to gather data on how well a course, or program, is meeting its intended outcomes. Huba and Freed define the following four steps for any assessment process:

- Formulate statements of intended learning outcomes
- Develop or select assessment measures
- Create experiences leading to outcomes
- Discuss and use assessment results to improve learning [102]

The first two steps are themselves cyclical. As the program's intended outcomes are changed, the assessment measures may have to change as well. Changes might include adding, changing, or removing direct or indirect assessment measures. The assessment plan and process need to be created with and integrated into the curriculum. So, as a faculty

member, or department, decides to make modifications to a course, the outcomes associated with that course may change, necessitating a change in assessment measures.

Creating and integrating assessment into a program can be tricky. MacGregor, Tinto and Lindblad posit that "when you are planning a program, how you will assess it is often one of the very last questions you ask yourself. But it shouldn't be your first question, either, a range of other questions often dictate what you end up doing and so should be considered first." [103] Since the assessment process should be created along with the program, there are pressing issues that take precedence over assessment questions.

Once one is ready to start designing the assessment process for a program, several questions have to be answered. MacGregor, Tinto, and Lindblad, among others, state there are several questions that need to be considered in the creation of an assessment process. These questions compliment the model that Huba and Freed suggest by adding detail. Five such questions are presented below, in an effort to describe how the assessment process should be designed.

"What mode are you in?" [104] In other words, is this assessment formative or summative? Answering the above question leads to very different ways of thinking about and approaching assessment. In the case of formative assessment, the assessment process is more informal. The program or course may be changed based on the data gathered from the assessment.

"What are the goals of the innovation?" [105] This question really asks what is the

program attempting (intending) to achieve. For any assessment program to be effective, it must have outcome measures that focus on these areas. For example, if a program is established to increase the first year rate of students in Computer Engineering, then at least one measure has to be the retention rate of first year computer engineering students.

"Who are the audiences with whom you intend to share the data and with whom you must hold a conversation about the evidence?" [106] The first question offers some clarification here. If your mode is improvement, and therefore you are doing a formative assessment, then the audience should include those that have provided resources and advice so far, as well as those that can offer additional support and resources.

"What data do you want to collect, and what methods do you want to use?" [107] This again can depend on what to prove, or who you are attempting convince. For instance, if the goal is to improve first year student retention in Electrical Engineering, you would want to have some quantitative data, in the form of retention statistics, and some qualitative data, in the form of student feedback, that credits the program for their persistence in the major.

"What are the strategies you will use to share the data?" [108] Rogers and Sando indicated three general reasons for assessment, and data must be gathered to support whichever of the three reasons the assessment is being performed. The data required not only depends on the type of assessment, but also the audience. The strategies help determine how and what data is necessary, given the audience for the assessment information.

Huba and Freed compiled larger list of key questions. These questions consider good assessment practices, and the institutional environment. The questions are:

- Does assessment lead to improvement so that the faculty can fulfill their responsibilities to students and the public?
- Is assessment part of a larger set of conditions that promote change at the institution? Does it provide feedback to students and the institution?
- Does assessment focus on using data to address questions that people in the program and at the institution really care about?
- Does assessment flow from the institution's mission and reflect the faculty's educational values?
- Does the educational program have clear, explicitly stated purposes that can guide assessment in the program?
- Is assessment based on a conceptual framework that explains relationships among teaching, curriculum, learning, and assessment at the institution?
- Do the faculty feel a sense of ownership and responsibility for assessment?
- Do the faculty focus on experiences leading to outcomes as well as on the outcomes themselves?
- Is assessment ongoing rather than episodic?
- Is assessment cost-effective and based on data gathered from multiple measures?
- Does assessment support diversity efforts rather than restrict them?
- In the assessment program itself regularly evaluated?
- Does assessment have institution-wide support? Are representatives from across the educational community involved? [109]

The key questions are consistent with the principles of good assessment practice, and enhance the process of creating an assessment program by forcing those involved to consider several environmental issues that may impact its creation and use.

In preparing the assessment portion of a program, one needs to consider what are good assessment practices. Huba and Freed identified two lists of principles for good assessment practice. The American Association of Higher Education (AAHE) produces one list of principles identified. This list was developed at the 1992 AAHE Assessment Forum, and serves as a guide to good assessment practice. The Principles are:

- The assessment of student learning begins with educational values
- Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated, and revealed in performance over time
- Assessment works best when the programs it seeks to improve have clear explicitly stated purposes
- Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes
- Assessment works best when it is ongoing and not episodic
- Assessment fosters wider improvement when representatives from across the educational community are involved
- Assessment makes a difference when it begins with issues of use and illuminates questions people really care about
- Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change
- Through assessment, educators meet responsibilities to students and to the public [110]

Both lists of principles share common characteristics. The goal is to design and perform assessments continuously, and honestly while serving a genuine purpose- to improve teaching and learning.

3 Design and Implementation of Evaluation Tools

Both CELTs and EELC use authentic assessment in the form of design projects. These design projects are assigned during the second semester in both learning communities, and focus on Electrical Engineering concepts (EELC) or Computer Engineering concepts (CELTs). The design projects provide extremely useful information regarding student learning, but these assessments occur at the end of the learning communities. CELTS and EELC need assessment tools that allow the faculty to gather information throughout the academic year.

CELTs uses some classroom assessment, but not a full assessment program. EELC does not use classroom assessment, or an assessment program. EELC does require that each student meet with the professor at least once during each semester. Both learning communities use authentic assessment, (also called skills assessment), in the form of second semester design projects. In each learning community, the design projects are based on some major course component. The EELC design project has traditionally been building a small device that incorporates an Electrical Engineering principle, such as a Ring Launcher and AM Radio. The CELTs design project has traditionally involved programming a mobile robot to perform a specific task. This task typically forces students to use many skills learned in the learning community course.

The evaluation tool in figure 2 is designed to help the faculty gather assessment data throughout the yearlong learning community courses, and make decisions based on an evaluation of that data. The assessment tool is designed to answer questions about how well

these two learning communities are meeting their intended (stated) outcomes. The evaluation tool is a multi-step process. It is as much curricular design as assessment, and evaluation, of that curriculum. Hubba and Freed, Wiggins and McTighe, Rogers and Sando, Angelo and Cross, and others suggest that assessment should be planned as the course, or program, is being planned.

As defined in Chapter One, assessment is the process of gathering data used to make programming decisions. Assessment data can be either direct or indirect measures. The most common form of an indirect measure is student attitudes. Student attitudes do not measure how much, how well, or how deeply a student, or group of students has learned, but can measure the attitudes (thoughts, feelings, and metacognition) associated with that learning. In other words, a student may not perform very well on exams, quizzes and homework, but still be excited and motivated to work harder at learning a particular subject. Direct measures of assessment include exams, design projects, quizzes, reports, and homework. These measures involve the students in activities in which the student has to perform, or demonstrate, some skill.

Evaluation is the process of applying meaning to the assessment data, with the purpose of making decisions regarding the program. Following the tool, changes can be made to the learning communities' curricula that would easily allow the faculty to make subsequent changes to the assessment tools. The tool reflects the close relationship between assessment, outcomes and curriculum.

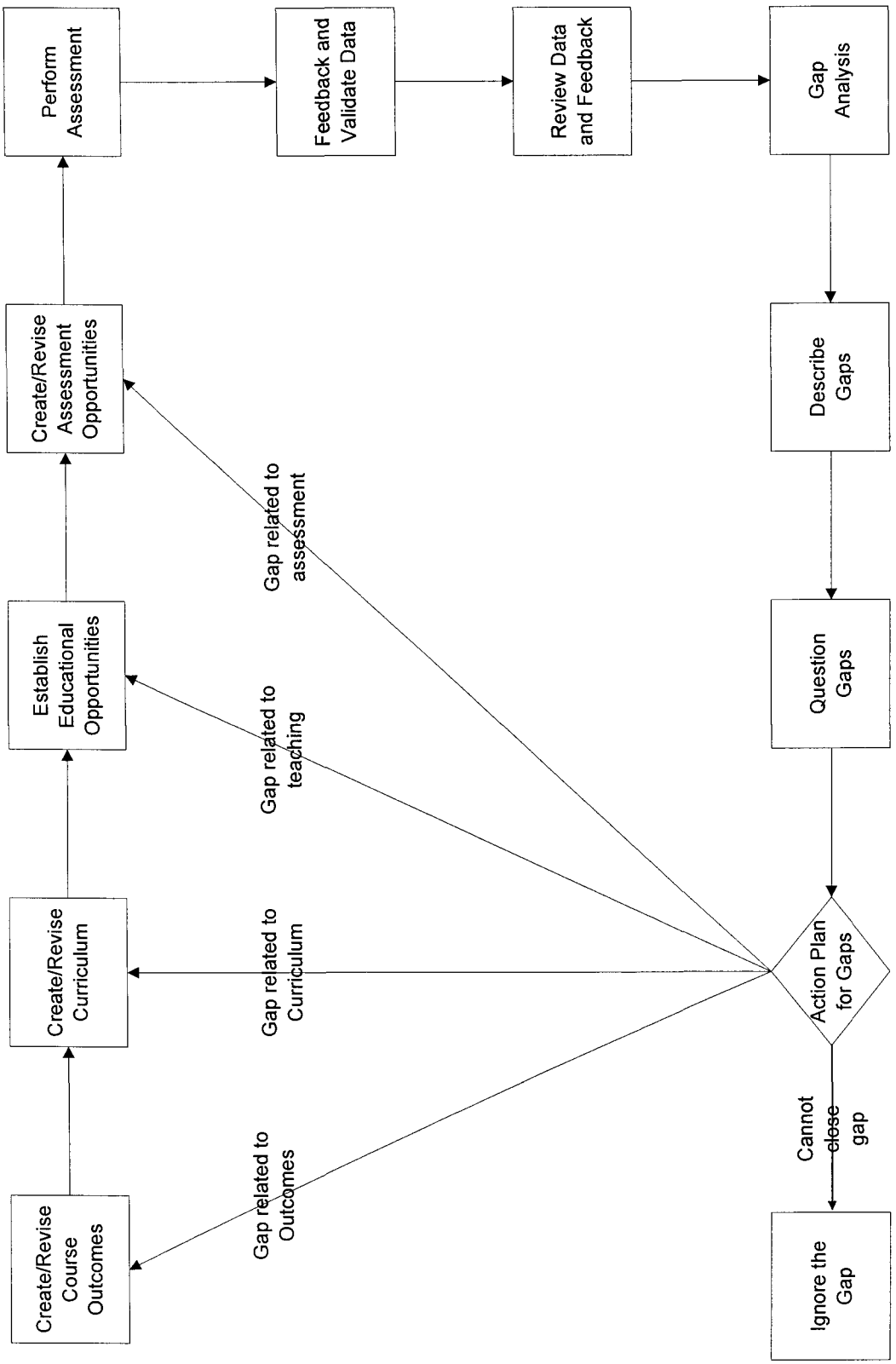

Figure 2. Evaluation and Assessment Tool

This evaluation tool is a mix of participant-oriented and management-oriented evaluation models. The Management-oriented model has been designed to serve the needs of decision-makers. "The management-oriented approach to evaluation was instrumental in showing evaluators and program managers that they need not wait until an activity or program has run its course before evaluating it. In fact, educators can begin evaluating even when ideas for programs are first discussed."[111] M.C. Alkin developed the UCLA Evaluation Model, one of the better know and used evaluation models, which is based on four assumptions:

- Evaluation is a process of gathering information
- The information collected in an evaluation will be used mainly to make decisions about alternative courses of action
- Evaluation information should be presented to the decision maker in a form that he can use effectively and which is designed to help rather than confuse or mislead him
- Different kinds of decisions require different kinds of evaluation procedures [112]

Alkin's decision-based (management-oriented) model, much like D.L. Stufflebeam's CIPP Evaluation Model, provides evaluation across multiple aspects of a program. Stufflebeam used the acronym of CIPP to describe the program aspects that will be evaluated- Context, Input, Process, and Product.

Management-Oriented evaluation models are very focused. The focus is usually a set of questions posed by decision-makers. This model also introduced the concept of formative evaluation to evaluators and program managers. Both the UCLA and CIPP models are designed to evaluate portions of programs, as they are being implemented and designed.

There are few limitations of the management-oriented model. The biggest weakness being that the evaluation is limited in scope to areas that are of interest to the decision-

makers. If the decision-makers are focused on issues or questions that will not aid in improving the program, then the evaluator is restricted to those questions that meet the needs of the decision-makers. Because the evaluation has decision-makers setting the evaluation focus, these type of evaluations can be misused. Decision-makers can specify performance indicators that can be misused or misinterpreted. Performance Indicators will be addressed at the end of the chapter.

Participant-oriented evaluation models are characterized by the use of many qualitative, as well as quantitative approaches to evaluation. In comparison to other models, the participant-oriented model does include qualitative approaches, not just focusing on quantitative approaches and data. Participant-oriented models tend to focus more on narratives and portraits. This evaluation model uses a multiplicity of data to describe and explain participant experiences with and attitudes about the program being evaluated.

R.E. Stake's Countenance Framework model is one of the most well known participant-oriented evaluations. Stake based his evaluation on two basic evaluation acts-description and judgment. Parlett and Hamiliton created the Illuminative model. The goal of this evaluation model is to illuminate problems, issues and significant program features. [113]

Participant-oriented evaluation models use similar quantitative methods for gathering data as other models, but include numerous qualitative methods as well. The use of qualitative methods allows evaluators to include the human element in the evaluation. These models are able to incorporate the needs and views of many different groups and

stakeholders, including decision-makers and program participants.

There are some limitations and weaknesses with Participant-oriented evaluation models as well. Evaluator subjectivity (bias) is one of the major criticisms of this model. The reliance on observations and individual perspectives means the evaluator has to interpret data. The use of evaluations based on this model tends to encourage activism in program participants. Worthen notes that students and parents in programs that have been evaluated with a tool using this model tend to be more politically active. [114]

By combining features of the two evaluation models, the evaluation tool is flexible. The assessment portions of the tool can be modified or replaced to focus on decision-maker questions and concerns. The tool can still be used to gather data on student attitudes and feedback. Decision-maker questions and concerns can be addressed without sacrificing student feedback. In fact, student feedback can augment other data gathered. Student feedback may provide depth to answers sought by decision-makers, and answer additional questions that decision-makers did not think to ask, or would ask as follow-up questions.

Create Outcomes

Intended outcomes, or goals, "describe the kinds of things that students know or can do after instruction that they didn't know or couldn't do before."[115] Wiggins and McTighe stress a backward design process- identify desired results, determine acceptable evidence, and then plan learning experiences. [116] Clear, student-focused outcomes are key. Huba and Freed sum up the importance of selecting outcomes first by stating three benefits- intended learning outcomes form the basis of assessment at the course, program, and

institutional levels; intended learning outcomes provide direction for all instructional activity; intended learning outcomes inform students about the intentions of the faculty. [117]

Outcomes set the tone, direction and level of expectation for a course or program. Intended outcomes let the students know what to expect to learn in a course, and this allows students to assess their own learning. Since students know what to expect, they can then provide feedback about the their learning, the teaching they are experiencing, and the overall learning environment. Feedback from students should be analyzed and acted upon quickly, and feedback should then be given to students. For example, students might indicate that they would learn more if laboratory exercises were more closely related to lecture material. Feedback to the students might include explaining the perceived disconnects between lab and lecture material (ie- temporary disconnect), or notifying students that disconnects would be resolved (lecture and lab material would be aligned).

Create/Revise Curriculum

Course curriculum should support the intended outcomes. The results generated by this assessment tool might lead the user to consider changes to the curriculum. If the curriculum does not support the outcomes, then either the outcomes must change, or the curriculum must change. Assessment feedback might lead the faculty member to add or remove parts of the curriculum. For example, the faculty member may have included material in the course that was covered in depth in a previous course, and students indicated this in their feedback. The faculty member can use this feedback to work with other faculty members to better align courses for future semesters, or simply adjust his course's curriculum.

With course outcomes in place, a faculty member can then design the curriculum around those outcomes. With outcomes in place, curricular priorities can be established by placing knowledge and skills into one of three categories- Worth being familiar with, Important to know and do, and "Enduring" understanding. [118] By classifying and prioritizing knowledge and skills, a faculty member can make important curricular decisions.

Establish Educational Opportunities

Once a faculty member prioritizes knowledge and skills for the curriculum, she must create opportunities for students to learn them. Lectures, labs, homework, and student-led class discussions are examples of educational opportunities. In addition, Cooperative Learning exercises such as Jigsawing, and turn to your partner (TTYP) are also opportunities for students to learn from each other.

Create Assessment Opportunities

Assessment of student learning and teaching should be continuous. Assessment should also include multiple measures and techniques to uncover learning and attitudes. Assessment opportunities are the key source of feedback from students in regard to their learning based on educational opportunities. Assessments can, and should, use both graded and non-graded items/techniques- Classroom Assessment Techniques (CATs), Continuous Quality Improvement (CQI) techniques, tests, quizzes, homework assignments, projects, and surveys can be incorporated into the assessment to help gather student data. By using graded materials, the faculty member is giving students feedback on their performance on expected tasks/skills. Students can then assess their course-related learning and skills, reactions to

teaching and teacher, and course-related materials, activities, and environment. Some techniques require minimal planning, resources, time, and effort, while others require careful planning and extensive resources. A mix of assessment techniques allows the faculty to create multidimensional assessment opportunities for students to give feedback on teaching, learning, and Metacognition (thinking about their own thinking). By creating continuous assessment activities, the faculty member can create an environment where students are continuously providing and getting feedback on their course and coursework. This should result in students feeling as though they are active participants in their own education.

The assessment tool incorporates many of the ideas of Classroom Assessment. Angelo and Cross developed Classroom Assessment Techniques, CATs, that enable faculty to get feedback on student learning, and in turn, give students feedback on whether their learning is in line with what the professor is try to teach. Classroom assessment is based on the idea that the best way to improve learning is to improve teaching. [119] Classroom Assessment is characterized as learner-centered, teacher-directed, mutually beneficial, formative, context-specific, ongoing, and firmly rooted in good practice. [120] Classroom Assessment is based on seven assumptions:

- The quality of student learning is directly, although not exclusively, related to the quality of teaching. Therefore, one of the most promising ways to improve learning is to improve teaching.
- To improve their effectiveness, teachers need first to make their goals and objectives explicit and then to get specific, comprehensible feedback on the extent to which they are achieving those goals and objectives.
- To improve their learning, students need to receive appropriate and focused feedback early and often; they also need to learn how to assess their own learning.
- The type of assessment most likely to improve teaching and learning is that conducted by faculty to answer questions they themselves have

formulated in response to issues or problems in their own teaching.

- Systematic inquiry and intellectual challenge are powerful sources of motivation, growth, and renewal for college teachers, and Classroom Assessment can provide such challenge.
- Classroom Assessment does not require specialized training; it can be carried out by dedicated teachers from all disciplines.
- By collaborating with colleagues and actively involving students in Classroom Assessment efforts, faculty (and students) enhance learning and personal satisfaction.[121]

Classroom Assessment is a good fit for this tool. Classroom Assessment provides two-way communications for faculty and students to give feedback on teaching and learning.

Different CATs can be used to target different types of learning, or understanding, and attitudes. Of the fifty CATs Angelo and Cross list, about half are designed to uncover learning, and the other half to uncover student attitudes. Researchers such as Benjamin Bloom, identified three domains related to educational activity- Cognitive, Affective, and Psychomotor. The Cognitive Domain represents mental skills (knowledge), the Affective Domain represents emotions or growth in feelings (attitudes), and the Psychomotor Domain represents manual or physical skills (skills). Bloom's Taxonomy divides each domain into levels, or subdivisions, and measures abilities by observing and/or testing behaviors. Bloom's Taxonomy of the Cognitive Domain is well known and many educators use sample verbs to test students cognitive abilities. Tests imply grades, and students are motivated to do well on tests. Students will learn what they need to know for a test, but this does not mean that students are learning or developing an understanding of the material that the faculty is attempting to teach.

Bloom's Taxonomy is described in Table 1. The first column lists each of the six knowledge levels. The second column is a definition of each knowledge level. The third

column lists verbs that, when included in test questions and/or class discussions, would allow students to demonstrate their level of knowledge on a topic. For example, asking students to "compare and contrast using Boolean Algebra and Karnaugh Maps to simplify Product-of-Sum Logic Expressions" would give them an opportunity to demonstrate their depth of Classroom assessment techniques are usually not graded, or used for grading or evaluating students. Classroom Assessment Techniques are typically anonymous feedback for faculty to understand "what, how much, and how well students are learning". [122] The nature of CATs allows students to give feedback without the pressure of grades. Students may not expect that an assessment exercise is about to occur, but usually relax when they understand that the exercise is not graded and/or anonymous. CATs are designed to measure student behaviors in both the Cognitive and Affective Domains. The fifty CATs can be categorized into three major divisions, and ten subdivisions. The categories are listed below and allow faculty to pick an assessment technique based on the feedback required:

Assessing the Cognitive Domain
Assessing Prior Knowledge, Recall, and Understanding
Assessing Skill in Analysis and Critical Thinking
Assessing Skill in Synthesis and Creative Thinking
Assessing Skill in Problem Solving
Assessing Skill in Application and Performance

Assessing Learner Attitudes, Values, and Self-Awareness
Assessing Students' Awareness of their Attitudes and Values
Assessing Students' Self Awareness as Learners
Assessing Course-Related Learning and Study Skills, Strategies, and Behaviors

Assessing Learner Reactions to Instruction
Assessing Learner reactions to teachers and teaching
Assessing learner reactions to class activities, assignments, and materials [123]

Two of the major divisions are Affective in nature, and one is Cognitive. These categories allow an instructor to focus on different types of questions regarding teaching and learning. The variety of CATs also allow an instructor to gather information in different ways. knowledge of the two reduction techniques.

Angelo and Cross have created many useful assessment techniques for use in the classroom environment. There are additional assessment techniques that have easily been adapted to provide feedback in the classroom environment. Just as techniques were created to empower continuous improvement in the classroom, via CATs, other feedback tools were created via Continuous Quality Improvement (CQI). CQI feedback techniques were designed to give users feedback about their customers' perceptions of products and/or services. CQI techniques have been adapted and introduced into the classroom environment. It should be noted that both CQI techniques and CATs yield feedback for the person administering, as well as the person responding to, the feedback mechanism. The responder has to become aware of her response(s) to the produce or service being delivered and, in some cases, evaluate her behavior.

Level	Definition	Sample Verbs	Sample Behaviors
KNOWLEDGE	Student recalls or recognizes information, ideas, and principles in the approximate form in which they were learned	Write List Label Name State Define	The student will define the six levels of Bloom's Taxonomy of the Cognitive Domain
COMPREHENSION	Student translates, comprehends, or interprets information based on prior learning	Explain Summarize Paraphrase Describe Illustrate	The student will explain the purpose of Bloom's Taxonomy of the Cognitive Domain
APPLICATION	Student selects, transfers, and uses data and principles to complete a problem or task with a minimum of direction	Use Compute Solve Demonstrate Apply Construct	The student will write an instructional objective for each level of Bloom's Taxonomy
ANALYSIS	Student distinguishes, classifies, and relates the assumptions, hypotheses, evidence, or structure of a statement or question	Analyze Categorize Compare Contrast Separate	The student will compare and contrast the Cognitive and Affective Domains
SYNTHESIS	Student originates, integrates, and combines ideas into a product, plan or proposal that is new to him or her	Create Design Hypothesize Invent Develop	The student will design a classification scheme for writing educational objectives that combines the cognitive, affective, and psychomotor domains
EVALUATION	Student appraises, assesses, or critiques on a basis of specific standards and criteria	Judge Recommend Critique Justify	The student will judge the effectiveness of writing objectives using Bloom's Taxonomy

Table 1: Bloom's Taxonomy of the Cognitive Domain

Some of the more commonly used CATs should be used with the assessment tool. Table 2 lists a recommended set of assessment techniques that should be used as part of the assessment tool. Most of these assessment techniques require very little preparation time and a short time to administer. The assessment techniques can be administered virtually anytime during the class. In addition, some of the assessment techniques can be combined. For example, a One-Minute Paper could be used as the method for obtaining a Background Knowledge Probe. Prior to beginning a lecture on a new topic, the professor could use the One-Minute Paper to probe for prior knowledge on the subject.

Perform Assessment

Assessment activities should occur throughout the academic year. By including tests, quizzes, assignments, and projects, students would know when those major activities would occur (via the syllabus). Most of the assessment activities would occur during lectures, labs, and learning community activities (outside of the classroom/lab). The majority of the activities would be informal in nature. The included survey would be administered late in the first semester- allowing students to reflect on that semester's teaching, learning, learning environment, how well expectations (intended outcomes) were met (educational opportunities aligned with intended outcomes), how well students participate in the community (outside of the classroom), and how the community can (or should) change.

Assessment Technique	What is Measured	Level of Assessment	Bloom's Level
Background Knowledge Probe	Knowledge	Recall/ Understanding [124] (Prior Knowledge)	Knowledge
One Minute Paper	Knowledge	Recall/ Understanding [125] (Metacognition)	Knowledge Comprehension
Muddiest Point	Knowledge	Recall/ Understanding [126] (Metacognition)	Knowledge Comprehension
Email Minute	Context and Teacher-specific feedback	Learner reactions to teaching [127] (Metacognition)	Evaluation
Application Cards	Knowledge/Skill	Conditional Knowledge [128]	Application
Student-generated Test Questions	Skill	Synthesis	Synthesis
Chain Notes	Context and Teacher-specific feedback	Learner reactions to teaching [129] (Metacognition)	Evaluation
Two-way fast Feedback (CQI)	Learning process and environment	Learner reactions to teaching and Teacher reaction to feedback [130]	N/A
Plus/Delta (CQI)	Learning/Learner process and environment	Metacognition	N/A
TTYP (alternate feedback technique)	Knowledge/Skill	Student works with a partner to formulate answers to in class questions [131]	N/A

Table 2: Recommended Assessment Techniques

The surveys are tailored specifically to each learning community. Each survey can be found in Appendix B. There are two surveys for each learning community- one Coordinator Survey and one Student Survey. Each student survey contains direct questions that specifically ask students to rate the learning community on how well it met its intended outcomes. Students are also asked indirect questions regarding certain intended outcomes. Questions 14 through 16, on both surveys, are questions related to student retention within ECPE.

The surveys are included in the assessment tool to include student attitudes. Besterfield-Sacre, Atman, and Shuman noted the importance of including student attitudes in program assessment:

> In particular, engineering students bring with them a set of perceived attitudes about engineering and their own self-assessed abilities. These attitudes and how they change throughout a student's undergraduate education potentially affects his/her perceptions of engineering, motivation to learn, self confidence, competency, performance, and retention in an engineering program. Further, attitudes developed during the undergraduate years can affect the extent that the graduate "engages in life long learning," understands "the impact that engineering solutions have on society," and remains knowledgeable of "contemporary issues." Hence, using attitudes to assess aspects of engineering programs provide valuable information for making programmatic improvements. [132]

In short, Besterfield-Sacre et al are equating student attitudes with many attributes that ABET and others cite as important and desirable attributes of Engineers. These attributes are measured by ABET's EC2000 Criteria as part of a program's Educational Goals and Outcomes. The use of student attitudes data will be discussed in more detail.

Gap Analysis

As part of the assessment process, the faculty, teaching both learning communities, will take surveys very similar to those of the students. These surveys are then used for Gap Analysis. Gap Analysis consists of defining the present state, the desired or 'target' state and hence the gap between them. [133] Gap Analysis is a tool most often used in Total Quality Management/Continuous Quality Improvement (TQM/CQI). Gap Analysis is an essential part of TQM/CQI in helping an organization determine how well it meets its stated objectives. How well an organization is meeting its objectives can be viewed from the perspective of the organization, and from the perspective of the organization's customer base. By allowing an organization to view itself from its customer's perspective can help an organization move closer toward meeting its objectives, in a manner consistent with its customer's needs.

TQM/CQI were traditionally used in the Manufacturing Sector, but was introduced to the Service Sector in the 1980s. In the Service Sector, TQM/CQI require a slightly different emphasis in data gathering and measurements. TQM/CQI rely on objective measures. When manufacturing a product, Quality Teams can measure whether assembled products meet design specifications, count the number of defective products per million produced, measure the amount of wasted material associated with the product fabrication, and measure the variability in the assembled product. Those involved in Quality Initiatives will also survey and interview customers. Customer experience and interaction with the product affects the customer response. For example, if one of the customers participating in the assessment is the purchaser, but not the user of the product, his experience and perceptions may be completely different from that of the user.

Florida Power and Light (FP&L) was the first Service Sector organization to win the Malcolm Baldrige National Quality Award as a service company. Education was included in the Baldrige Program in 1995, via the Education Pilot [134], and 1999 as a Baldrige Program Category.[135] CQI and Assessment improve organizations and programs by using feedback. CATs and CQI techniques are very similar as well. [136] This assessment tool takes advantage of the similarity to use GAP Analysis to further analyze survey responses.

In the assessment tool, the faculty survey response is treated as the "target" state, while the mean student response is the present state. The goal of using Gap Analysis is two-fold: to indicate the current state of the learning community versus the faculty-defined ideal (mean student response), and to provide an internal check for the faculty member on the state of the learning community (faculty response versus student response).

Feedback and Validate Data

The assessment tool survey includes Qualitative and Quantitative questions. Many of the questions give respondents the opportunity to answer the questions on a 5-point Likert Scale and include some open-ended responses. By giving the students an opportunity to write comments (qualitative response), the faculty can gather additional information that cannot be included in quantitative questions. Holding focus groups with the learning community students is an excellent opportunity to validate the data from the surveys. The survey data might lead to questions that can only be answered by the students. The group setting also is an opportunity for students to discuss their responses, and come to consensus.

A neutral party familiar with running focus groups is appropriate- this removes some bias and offers students some anonymity.

The ability to gather information on student attitudes is an important part in evaluating these learning communities. Both learning communities are focused on the retention of ECPE students. Student retention is an important component in student persistence in a program, and therefore a key component in a student's decision to stay in a program. In addition, capturing student attitude data early in the program helps form baseline data for a student cohort.

Review Data and Feedback

Combining the data from assessment activities offers perspective on the students in the learning communities- their successes (and failures), their attitudes towards learning and working in a cooperative learning environment, their attitudes towards their chosen major, (and continuing in that major), and their attitudes towards the teaching in their respective learning communities. The data also gives the faculty members, teaching these two learning communities, feedback regarding their teaching, choice of educational opportunities, and strengths and weakness in the learning communities.

Feedback is also important to the students and other stakeholders. Students traditionally get no feedback from their responses. Classroom Assessment encourages giving students feedback. Feedback to the students in the learning communities would allow them to feel as if they are partners in their learning. Both learning communities also produce

annual reports that are a ready feedback channel. The Learning Community Assessment Sub-Committee and the Provost Office are major audiences for the reports. Student feedback is also of interest to perspective Electrical and Computer Engineering students and their families.

Describe Gaps

With TQM and CQI, Gap Analysis is used to highlight areas of opportunity. Both the organization and customer groups take surveys indicating the organization's current state. By comparing the customer and organization responses, the organization can see how its view of its current state differs from its customer's view. Gaps between the two views are considered statistically significant if they are 1.0 or greater. Statistically significant gaps are usually the first places to start revisions in the program.

Question Gaps

Once the gaps have been uncovered, there are some questions that need to be asked about the gaps. Are any of the gaps familiar or new? Are the gaps closing, widening, or the same? Can the gaps be closed?

Since assessment leads to change, with the goal of that change being improvement, it is possible that changes to outcomes, curriculum, and/or educational opportunities can affect the previously recorded learning community gaps. When a new set of gaps is uncovered, the first question that needs to be asked is "are any of these gaps the same as previous uncovered ones?" If the answer is yes, then the other primary questions should be asked regarding those gaps. If the gaps are new, then the faculty member should examine the survey responses and

other data for reasons for the gaps. Students can also be asked about the gaps. Feedback to students can also include additional clarifying questions.

If a gap, or gaps, continues year-to-year, one of the questions that should be asked, and answered, is "are these continuing gaps closing, widening, or are the same?" This question seeks to answer whether progress is being made in closing a gap, or set of gaps- this is the real purpose of using Gap Analysis. If progress is being made toward closing the gaps, then the faculty member needs to review changes that have helped in closing the gaps, and uncover additional changes that may shrink the gaps more. Every change will not result in the gaps closing.

As gaps continue year to year, the question of whether those gaps can be closed needs to be addressed. Some gaps may not be closed. As with quality improvement efforts (TQM, CQI, and ISO 9000), the learning communities might uncover gaps that exist simply because of perception, expectations, or preferences of customers (students). For example, the majority of students may expect that all students participating in the learning community should live together in the residence halls. This majority might express some dissatisfaction because some students chose to live (or had the option to live) elsewhere. This might be ideal for the learning community environment, but it is not ideal for students that choose to live elsewhere. If this sentiment gets expressed as a gap, it is unlikely that the learning community can maintain its flexibility and close it.

In general, "service quality characteristics are more difficult to define than those of physical products. This is because they include many important subjective elements." [137]

With products, quality can usually be linked to poor or faulty design, defective components, poor durability, and faulty or improper manufacturing. The organization's employees and its customers may never come into direct contact each other.

Services, unlike products, usually require direct contact between the organization's employees and its customers. This direct contact means that the quality of the service is affected by the attitudes and behaviors of the employees and the customers. This means the service cannot be separated from the employee delivering the service, and the customer purchasing the service. In addition, the delivery of the service has to be timely, and the service has to be executed without fault. The customers' perceptions and expectations will ultimately determine the service quality.

Educational institutions are service organizations. Educational institutions have a unique relationship with their external customers (students). The students may not fully understand the breadth and depth of the service they are buying, or what constitutes the quality of that service. Additionally, students have diverse expectations. Another factor that students often confuse the reputation (quality) of the institution with the quality of a particular degree program. An additional factor is students' perceptions change over time. As students progress through their degree programs, they develop confidence and experience, and this impacts their perceptions of quality. Lastly, students interact with this service, greatly affecting the quality of the service they receive.

Given the above factors, it may be very hard to close some gaps. Gaps may exist simply because student perceptions and expectations of the Learning Communities, the

faculty, the mentors, their peers, or perceptions given to them by their parents, friends or other students. The tool includes, in the survey, places for students to write in their comments. Focus group sessions are used to verify student survey responses, and also provide opportunities to probe for the underlying causes of the gaps.

Action Plan for change

Based on the data collected, the faculty in charge of these two learning communities can determine what actions they might want to take to improve their communities. Actions may include creating or revising outcomes, curriculum, educational opportunities, and/or assessment techniques. Another possible action is to survey the students at a later date. As Sallis noted, student perceptions change as they interact and learn. [138] Administering the survey near the end of the first semester provides good feedback, but administering the survey a second time- preferably in mid-April, would allow the faculty to compare data before initiating changes. The students are asked questions on the survey that can only be answered after the start of the second semester. An alternative solution is to use two versions of the survey- one that asks about activities of the first semester and one that asks about all activities in both semesters.

Use of the evaluation tool generates performance indicators. Performance indicators are nothing more than measures against standards established by the learning communities' coordinators. Like the performance indicators created from completing the Malcolm Baldrige National Quality Award Program Assessment, the indicators from the evaluation tool will allow the learning community coordinators to know what the learning communities' strengths are, uncover the weaknesses, and have some ideas for how to improve those

weaknesses. [139] Like Baldrige, or any other self-assessment, this tool provides a snapshot of how the learning communities are performing against standards. Unlike other non-Baldrige assessment tools, this tool incorporates the self assessment of the learning communities' coordinators- a key feature of the Baldrige tool, but unlike Baldrige, it does not include benchmarking against other like learning communities, is informal, and is nearly transparent to the learning community participants.

Performance indicators can be misinterpreted and misused. It is imperative that the learning community coordinators are aware of their audiences before producing performance indicators. [140] Different audiences will view performance indicators differently- seeking to use the indicators as answers to their questions. For example, the ECpE Department could use performance indicators as a measure for retention purposes, while a faculty member could use them as a measure of student preparedness for a future class.

It would be possible to make comparisons between classes within the same Learning Community. The Registrar's Office has the ability to track and gather data on student performance. This data could also include High School Class Rank (HSR), ACT and/or SAT scores, and other information. This would allow some benchmarking against ECPE students who did not participate in a learning community. The ability to include additional data may provide for additional comparisons and explanations in variability between participating groups in different years.

4 Results and Recommendations

The surveys for both CELTs and EELC were tested in trials with students from the two learning communities. This chapter outlines the testing and results of the surveys. The survey data is quantitative and qualitative.

Method

The participants were students enrolled in the EELC and CELTs Learning Communities. The surveys were distributed, administered, and collected during the final class meetings in December 2002, for both EELC and CELTs, and in December 2003 for CELTs.

The surveys were designed to identify groups within each learning community. Two groups within CELTs were easily defined as students that live on one of the three CELTs houses in Friley Hall (On-House), and students that lived elsewhere (Off-House). Some CELTs students actually lived in Friley Hall, but not on one of the CELTs houses, so these students are classified as Off-House. The impact of this decision will be discussed further as part of the discussion of the survey results.

Two groups were also identified for EELC. The number of first year students classified as Computer Engineers has been significantly higher than the number of first year students electing Electrical Engineering as a major. During the 2002-03, there was approximately four times the number of students entering Computer Engineering than Electrical Engineering. Since all first year students enrolled in the ECPE Department are required to take EE185 and 186, or CPRE185 and 186, the scheduling of these classes is

critical. Given the number of students enrolled in Electrical Engineering, some of the sections of EE185 and 186 were scheduled with a mix of EELC and non-EELC students. For the EELC Survey, the groups were identified as either EELC or non-EELC students. While the students took the same class, the students participating in the learning community had similar schedules.

The ability to define distinct groups within each learning community environment allowed for testing of some observations and hypotheses. These observations and hypotheses were posed as the following questions:

- Is there any difference in attitude toward CELTs between On-House and Off-House students?
- Is there any difference in attitude toward EELC between EELC and non-EELC students?
- Is CELTs meeting its educational outcomes?
- Is EELC meeting its educational outcomes?
- Are there gaps in CELTs?
- Are there gaps in EELC?

The expectation is that the survey will provide some usable data that, when combined with data gathered from other techniques, will answer the above questions.

Procedure

The survey data was gathered and student responses were entered into an EXCEL file. Each survey was assigned a number, and the responses from each survey were entered using that number. Any written comments were entered into a second EXCEL Worksheet, using respondent number as an identifier. The respondent number was listed down the rows, and responses to questions were entered across columns. A column for comments was added to

allow the person recording the data to add observations and notes. This column was used to note when respondents did not complete the survey, stated they were changing majors, or leaving the university.

The written comments were then grouped by question. By grouping the responses, general themes emerged from student responses. If the theme needed further probing, then the question and generalized responses were added to the list of questions for the focus groups. This allowed students to elaborate and discuss their responses in a group setting.

Focus group sessions were held during the Spring 2003 Semester as a follow-up to the surveys. These sessions gave students the opportunity to validate and comment on the general attitudes towards the learning communities. These sessions also gave the researcher an opportunity to probe deeper into answering the questions regarding the performance of the learning communities.

Learning Community Coordinator Surveys were given to the faculty in charge of the learning communities. These surveys contain a subset of the twenty questions on the student surveys. The questions are also modified to cause the faculty to reflect on their teaching behaviors. Gap Analysis was then performed using the averaged student data and faculty data. Potential gaps were identified, and compared to student feedback. The gaps were then classified.

Lastly, the data was analyzed using One Sample and Independent Sample T-tests. These statistical tests were performed to provide statistically sound information on the

questions above. While the research felt there was a difference in attitude, towards the CELTs Learning Community, between the identified student groups, there was little student data to support that belief.

Results

The survey results can be found in Appendix C. The results include the raw survey data in EXCEL spreadsheets, focus group notes and statistical analysis. The results will be summarized below.

The quality of the survey data is important for evaluating the Learning Communities. Leydens et al noted that, "In general, quantitative methods are designed to provide summaries of data that support generalizations about the phenomenon under study."[141] In short, quantitative data can yield averaged answers. For example, a class may rate a professor 3.5/5.0 on "Preparedness". The motivations and reasons behind that rating cannot be found in strictly quantitative data. To gain an understanding of how the students arrived at their ratings, one has to use qualitative methods.

There is a lot of quantitative data to be gathered in the form of tests, quizzes, homework, and laboratory exercises. That data can give the learning community coordinators a good idea of how the students performed on graded tasks, and possibly some idea of potential modifications that might improve learning. The true driver of evaluating the two learning communities is in understanding how students arrived at those scores. That information is only available by using qualitative methods of data gathering. Since the objective is to provide the learning communities with a method of measuring how well they

met their learning outcomes, measuring student attitudes are very important.

Yao et al note that faculty use student feedback in different ways. Using the Student Rating of Instruction (SRI) feedback from 636 faculty at multiple universities, Yao determined that faculty used the feedback most often in creating atmosphere, motivating students, presenting engagingly, providing challenge, setting course pace, and setting course objectives. [142]

Some Off-House CELTs students literally lived on the house next to a CELTs House. In the extreme case, a student's room was on the other side of the wall from Anthony house. These students' experiences probably more closely resembled that of On-House students, but they were not able to participate in the house activities. The Department of Residence policy restricts the number of students living on a specialty house (CELTs, Honors, Women in Science and Engineering, etc) to approximately 50% of the house. This policy ensures that learning community students interact with other students, and are exposed to a broader experience.

These students lived near a CELTs house, participated in activities with the mentors on those houses, and studied and interacted with On-house students daily. they could not fully participate with house activities (government, meetings, some activities), 2) for some students living in friley hall, their not living on a CELTs house was a barrier to participating in the CELTs houses activities 3) some On-House and Off-House students did not want to participate in CELTs activities outside of class 4) where do you draw the line for Off-House students? Using student living arrangements allowed me to account for most of the effects of the Living/Learning option. Will talk about survey

improvements later.

- Is there any difference in attitude toward CELTs between On-House and Off-House students?

Overall, there was a statistically significant difference in student attitudes based on living arrangement. Using Q1 as a treatment meant the researcher could perform a 2-Tailed T-Test. The Null and Alternative hypothesis are shown below:

H_o: $\mu_0 = \mu_1$, There is no difference in attitude for On-House and Off-House

H_A: $\mu_0 <> \mu_1$, There is a difference in attitude for On-House and Off-House

Observations had been made during the first three years of this learning community that suggested there was a difference in attitude, between On-House and Off-House students, toward the learning community. These observations were usually comments made by students. Table 3 contains 2002 CELTs information about questions with significant differences between On-House and Off-House students.

Question	Group	n	Mean	Sig (two-tailed)
Q2	0	24	2.25	.000
	1	35	3.36	
Q3	0	24	2.75	.000
	1	35	3.83	
Q6	0	24	2.63	.002 (.005)
	1	35	3.54	

Table 3: 2002 CELTs Results

To compile the above results, multiple t-Tests were performed. For the entire family of t-Tests, an alpha of 5% ($\alpha = 0.05$) was considered acceptable. This meant a probability of a Type I error (rejecting a Null Hypothesis which in fact is true) was 5%. If there was only a single t-Test (comparison) performed, then the probability was 5%, but given there were multiple tests (comparisons) performed, alpha is really computed to be:

$\alpha_f = 1 - (1 - \alpha)^n$, where n represents the number of comparisons, α represents the significance level of each comparison, and α_f represents the significance level for the entire family. [143]

According to Larpkiataworn et al, the above formula represents the classical Bonferroni Procedure for multiple comparisons. [144] This is a statistically accepted method for multiple comparisons of data using either parametric or non-parametric statistics.

Question 2 asks if students feel connected to the learning community. Students clearly made a distinction between their courses (including CPRE185) and the learning community. On average, the On-house students rated their feelings of connection to the learning community higher than Off-House students. Some On-House students did not participate in peer-mentor-led activities, including study sessions and office hours. These On-House students scored Question 2 much like Off-House students. The On-House, and Off-House, students that did participate in activities scored Question 2 the same.

Question 3 asks if students feel connected to other students in CELTs. There was a difference between On and Off-House students. Again, the students made the distinction between CELTs and their courses. While both groups of students rated their response to this question higher than Question 2, the Off-House students rated their responses to this question much higher. What is not known is if the difference, in Question 3, can be completely accounted for in the difference from Question 2. Some of the On-House students commented on not just having common courses with their peers, but also sharing common interests. These students commented on getting

together with other CELTs students to study, to do homework, and to participate in extracurricular activities. Some Off-House students commented that even though they did not live on a CELTs house, they did know and sometimes study with their peers that were On-House.

Question 6 asks students of they felt CELTs provided them with academic support. There was a statistically significant difference between On- and Off-House students if the assumption of equal variances between the two groups is true (significance = .002). On-house students that needed help, or took advantage of the availability of the peer mentors responded differently than Off-House students.

Table 4 contains the results for the Fall 2003 CELTs survey. As with the 2002 survey data, there is a statistically significant difference between On-House and Off-House students with regards to feeling connected to CELTs. The students were able to distinguish between the learning community and their peers in the learning community.

Question	Group	n	Mean	Sig (two-tailed)
Q2	0	30	2.50	.000
	1	39	3.33	

Table 4: 2003 CELTS Results

Student comments, on the surveys and in focus group sessions, were clear that CELTs should incorporate a few extracurricular gatherings to pull students together. The general attitude was that CELTs students got to know each other in the classroom or lab setting, but did not have much contact outside of the specific learning community

group to which they were assigned. CELTs students that only had CPRE185 in common with their peers really had no sense of belonging to the learning community at all. Some students are not going to participate in study sessions, or other activities that involve academics. A segment of these students feel they cannot study in groups. Another segment simply is taking such a different set of courses that the CPRE185 is their only common course with other CELTs students.

- Is there any difference in attitude toward EELC between EELC and non-EELC students?

Since all Electrical Engineering students participated in EE185/186 and there is no residential component to the EELC, the major difference between students is whether they elected to join the learning community. Students that did join the learning community were assigned reserved seats in Calculus (MATH165), Chemistry (CHEM155 or 167) and Engineering (EE185 and ENGR101) courses. Using Question 1 as a treatment, the Null and Alternative Hypotheses are shown below:

H_o: $\mu_0 = \mu_1$, There is no difference in attitudes for EELC and non-EELC EE students in EE185.

H_A: $\mu_0 <> \mu_1$, There is a difference in attitudes for EELC and non-EELC EE students in EE185.

There were no observations that implied there was a difference between students based on the participation in the learning community. This question seemed to be a place to start looking into the departmental impacts of the learning community. Since there was only one non-EELC student responding to the survey, there are no conclusions that can be drawn for this question.

- Are there gaps in CELTs?

The question of whether gaps exist in CELTs was the next question to be explored. The mean student response to several questions was compared to the learning community coordinator's responses. One method of answering this question is to use a One-Sample t-Test with a test value. The test value used would be the coordinator's rating in response to a question. So, for any question, or group of questions with the same coordinator response, the Null and Alternative Hypotheses would be:

> H_0: μ_0 = coordinator rating, There is no difference in the mean student ratings and faculty ratings for CPRE185
>
> H_A: μ_0 <> coordinator rating, There is a difference in the mean student ratings and faculty ratings for CPRE185.

Instead, Gap Analysis was applied in the same manner, as an organization would use while going through a Continuous Quality Improvement cycle. The faculty and student ratings are compared. The student rating is subtracted from the faculty rating and the difference is recorded. If the difference on any rating is greater than one, then the difference in rating is considered statistically significant, and should be investigated further. Differences close to one should also be examined. Table 5 lists the results of Gap Analysis on the 2003 CELTs data. The 2003 data was used because there was no faculty survey given to compare with the 2002 data. The only big gap that appears is associated with Question 12.

The student response to Question 12- "Understand Study Skills and Learning Styles" asks students to rate the opportunities to understand study skills and learning styles. Several students commented on this question. Two students correctly noted that learning styles were discussed in ENGR101. Two other students stated they learned

about learning styles either on their own or in high school.

Question	Mean Student Response	Coordinator Response	Difference
2	2.971	3	- 0.029
3	**3.232**	**4**	**-0.768**
6	**3.179**	**4**	**-0.821**
8	3.412	4	-0.588
9	3.412	4	-0.588
10	3.235	3	0.235
11	3.677	3	0.677
12	**3.338**	**2**	**1.338**
13	2.492	2	0.492

Table 5: Gap Analysis using 2003 CELTs Data

The learning community coordinator response to this question indicates that there were few activities in this area. The student response would indicate that there were some activities in this area. The student rating may be an indication of a Halo Effect. The Halo Effect occurs when someone overlooks less-than-desirable attributes in a person, product, or program because of an attribute he finds highly desirable. Learning communities can be subject to the Halo Effect and other bias.

Question 3 was discussed in a previous chapter. The student survey responses were reflected in their comments during the focus group sessions. In general, the students had made connections with each other. There was a sense that their connections were due more to their own efforts, and not any organized effort on the part of CELTs. The students indicated they would rather have more organized CELTs activities to encourage their bonding as a community. The students do not view peer mentor activities as part of the learning community activities. So, the gap may be a

misconception held by the students.

This apparent gap is a good example of how the learning community can use the evaluation tool as a feedback mechanism. Given the students' perceptions about learning community activities, the faculty coordinator can discuss this issue with students. That discussion should include more probing to better understand student attitudes about this area of the learning community. This is also a good opportunity to ask students what CELTs can do differently to better meet their needs in this area.

Question 6 asks "Do you feel CELTS has provided you with academic support?" The student survey responses varied. The general response could be split into groups of students that sought out help from the peer mentors or attended study sessions, and those that did not seek out help. How students replied did not depend on whether they were living On-House or Off-House. Written feedback indicates that some On-House students did not seek help and, in isolated cases did not know help was available. These student rated CELTs lower on this question. Some Off-House students attended help sessions and rated CELTs higher on this question. In addition, some students commented that there was usually someone around from which to seek help, or to study with. This indicates that these students viewed each other as resources and academic support.

- Are there gaps in EELC?

The treatment method applied to the CELTs data was also applied to the EELC data. Gap Analysis was used to compare the student and faculty coordinator responses. A gap is

identified as a difference of one or greater. As with the CELTs data, differences close to one should also be examined. If parametric statistical methods were to be used to test the data (such as t-Tests), then the following Null and Alternative Hypotheses would be appropriate:

H_o: $\mu_0 = \mu_1$, There is no difference in the mean student ratings and instructor ratings for EE185.

H_A: $\mu_0 <> \mu_1$, There is a difference in the mean student ratings and instructor ratings for EE185

Question	Mean Student Response	Coordinator Response	Difference
2	3.38	4	-0.62
3	3.53	4	-0.47
6	3.71	4	-0.29
8	**3.76**	**5**	**-1.24**
9	3.71	4	-0.29
10	3.59	4	-0.41
11	4.35	4	0.35
12	3.88	4	-0.12
13	2.94	3	-0.06

Table 6: Gap Analysis using 2002 EELC Data

Question 8 asks students to rate their opportunities to "Learn about basic Mathematical principles necessary for Electrical Engineering (Matrices, Linear Interpolation, etc)". The faculty coordinator commented "This is perhaps one of the strengths but it is Math in context". The students rated their opportunities lower. This may be another example of either a perceptual gap, or simply students misunderstanding the question. If the students misunderstood the question, then rephrasing the question is appropriate. The responses during the focus group indicated that the students were not expecting, or did not understand that, the mathematics to be in an Engineering context.

- Is CELTs meeting its educational outcomes?

CELTs has met its educational outcomes. The majority of students had positive

attitudes towards the learning community. Students that indicated that they were leaving the major usually had positive attitudes towards the learning community. The only students that did not make positive comments about the learning community were students that had little participation in the learning community.

There are areas of improvement for CELTs. A few CELTs-sponsored activities would change some student perceptions that the learning community does not hold activities or meetings outside of class. Holding study and help sessions in Coover Hall, or another non CELTs House location might improve Off-House student participation, thus changing the attitude that CELTs does not provide academic resources. CELTs does host an electronic message board that some students in the 2003 group noted as an information resource. Inviting other ECPE faculty to attend activities and meet the students would also help integrate students into the department.

- Is EELC meeting its educational outcomes?

EELC has met its educational outcomes. Students clearly enjoyed the first semester in the learning community, and were very excited about participating in EE186. The students were interested in having all EELC students participate in all activities. They were divided on how to get everyone involved, but thought it was important that everyone be involved. Some students believed that the Living/Learning Option was a good approach, while others believed that a housing option would take away their ability to make their own housing decisions.

The student perceptions about how mathematics and C programming were presented were the biggest areas for improvement. The students were not comfortable

with being asked to work on ill-defined problems. While many of them appreciated what they were being taught, they were not comfortable with the method.

Improvements and recommendations

There are a few areas of improvement for the evaluation tool. The first area is in wording of the questions. A few students either did not understand what was being asked, or did not read the questions carefully. Questions 4 and 5, on each of the student learning community survey, should be carefully examined to determine if there is a better way of wording them. Someone, with expertise on surveys, should read the surveys for clarity. The majority of students answered the questions in a manner that suggested they understood the questions, but there may be a way of rewording the questions to elicit more in depth responses.

The surveys should be modified for Fall and Spring semester administration. The survey for the fall semester should not include Question 13- Opportunity to practice presentation skills, as neither learning community gives the students the opportunity to present during that semester. The survey for the spring semester should have Question 13. Questions 4 and 5 may also not be appropriate for the spring semester. These questions might be replaced with follow up questions regarding the transition to college life.

Someone familiar with facilitating focus groups should conduct the focus group sessions. This would eliminate some potential bias from the sessions. In addition, the students may be more comfortable answering questions and participating in the

discussions with someone they perceive as having no agenda in hearing certain answers. In addition, the focus groups should be held earlier. The ideal time would be at the end of the fall semester, and two weeks prior to the end of the spring semester. Hosting the sessions earlier would allow for data to be compiled, and feedback to the students to happen at the beginning and end of the spring semester. Decisions regarding changes can be communicated to students in a reasonable timeframe, and the students would feel as if their feedback counted.

The surveys should also be administered earlier in the semester. Mid-semester might be an ideal time for the surveys. This may require some additional modifications to the surveys. By administering the surveys at mid-semester, the faculty coordinators have time to analyze the results, hold focus group sessions, and report back to students on changes.

The fall semester survey could yield interesting discussions that change planning for the spring semester. That same data might be used to introduce students to topics and activities in the spring semester. Survey results from the spring could be used to talk with students about changes they would like to see in the learning communities. In this case, the students are asked to reflect on the entire learning community experience and decide on changes.

Comparing the departmental survey to the evaluation tool

This evaluation tool is better suited to measure how well the two Learning Communities are meeting their intended outcomes, than the current departmental survey tool,

because it has been designed, and customized, specifically to measure those specific learning community outcomes. Specifically, the survey is better designed for gathering assessment data than the Departmental Survey. The departmental survey offers few data points for faculty trying deciding on modifications to make to a course.

The standard ECPE Departmental Surveys can be found Appendix A. These surveys are general survey tools for all departmental courses. The general nature of these surveys means they are not designed to gather assessment data for the learning communities. In addition, these surveys were created before either learning community was created, and have not been modified for the learning communities. The surveys focus on general areas- Text and Course (appropriate text and course pacing), Instructor (preparedness), and Additional Evaluation (appropriate credit hours, equipment, and support resources). In reviewing the Lecture Evaluation, there is only one of twenty questions that gather any useful assessment data for making evaluation decisions for the learning communities.

In Chapter 2, the AAHE Guidelines for good assessment where discussed. These guidelines are designed to help make assessment and evaluation simpler for faculty and units to engage in. The guidelines are listed below:

- The assessment of student learning begins with educational values
- Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated, and revealed in performance over time
- Assessment works best when the programs it seeks to improve have clear explicitly stated purposes
- Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes
- Assessment works best when it is ongoing and not episodic

- Assessment fosters wider improvement when representatives from across the educational community are involved
- Assessment makes a difference when it begins with issues of use and illuminates questions people really care about
- Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change
- Through assessment, educators meet responsibilities to students and to the public

The evaluation tool follows the AAHE Guidelines closer than the departmental survey. Although the departmental survey could be part of a larger evaluation and assessment program, it does not provide enough information for a course or department.

One of the general guidelines for effective assessment is to work backwards from goals to develop outcomes and learning opportunities. Once a professor decides what skills and knowledge a student should come away with from a course, it is then a matter of deciding: 1) how a student should demonstrate possessing that set of knowledge and skills, 2) how to effectively teach the set of knowledge and skills, and 3) how to assess the students. Effective assessment and evaluation are integrated into the structure of the course or program. Assessment becomes invisible, yet the students are aware that their feedback in incorporated into the course. Students also become an integral part of the teaching and learning process. The current departmental survey is not designed to meet those guidelines.

5 Additional Applications

This chapter will discuss other potential uses for this evaluation tool. As outlined in Chapters 3 and 4, the evaluation tool relies on triangulation and student feedback. The tool produces the best results when it is used repeatedly, as part of an ongoing program to improve teaching and learning.

Figure 3 illustrates the use of the evaluation tool. The use of the tool creates a set of data that is unique to a specific course taught during a specific semester. Pairing the tool results with the syllabus and list of educational opportunities forms a data point. So for a course taught every other semester, the data gathered is used to make decisions and modifications for the next time the course is taught. Those changes are incorporated into the teaching plan for the next time the course is taught, and at the end of that semester, a new set of data is compiled.

Engineering Colleges are becoming very proficient at articulating their outcomes; this skill is also being developed within departments as well. Departments are also developing the ability to target specific courses that support each outcome. These skills are a result of the implementation of the ABET EC2000 Criteria. Ewell suggests that assessment tools can be modified to allow departments to determine and measure how well courses, in sequence, fit.[146] Another modification, suggested by Ewell, is identifying and measuring how well

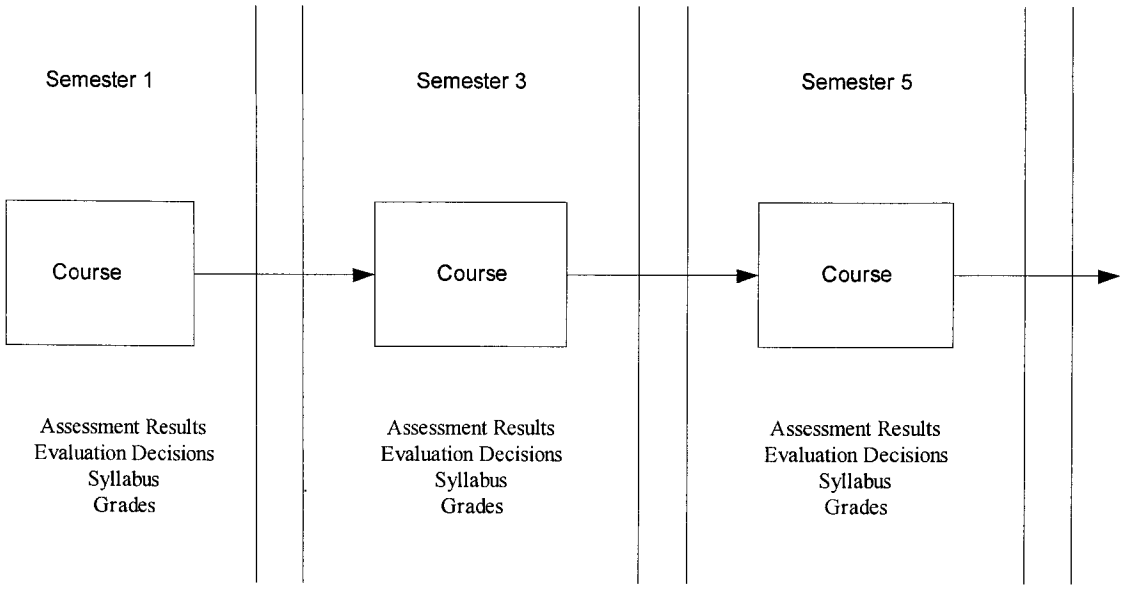

Figure 3: Using the Course Evaluation as a Continuous Quality Improvement Tool

the outcomes of pre-requisite courses support the outcomes of key courses in sequence.[147] Lastly, the tool can be modified to collect longitudinal data on course and program changes, based on evaluation decisions. As situations change, faculty make modifications to courses. New tools, texts, techniques, faculty and technologies can impact what is taught in a course. Changes in post-requisite courses may dictate changes in pre-requisite courses. For example, the adoption of a new circuit simulation tool for a Computer Architecture course may facilitate a change in how the pre-requisite Digital Design course is taught. Ewell noted, "Even in relatively structured curricula like engineering, individual courses may or may not fit together as they were intended. A major assessment challenge- and often a topic of immediate interest to faculty as well- is therefore to determine how well particular sequences of courses actually operate." [148] As changes occur, the question of how those changes affect the curriculum, and sequence, is an important one to answer.

There are potential impacts to course changes. The changes may result in too much time passing between the introduction, in a prerequisite course, of knowledge and skills and the application in post-requisite courses. As a consequence, the same material will have to either be introduced again, reviewed, or ignored (ie- students are held responsible for going back and relearning the required knowledge and skills on their own). Regardless of the decision, students lose the benefit of being able to build on foundation knowledge and skills.

Another potential impact is the curriculum is rendered unworkable from the student perspective. At that point, students take courses out of sequence. As implied above, if key knowledge and skills are not being built upon from one course to the next in a sequence, faculty decisions will allow and/or force students to move through the curriculum in ways not

intended. Students will decide to take classes in a different sequence than the department intended. How students decide to do take classes will be based on feedback mainly from other students.

Another potential impact of course changes is students are introduced to key knowledge and skills, but in a context that differs from the context in post-requisite courses. On the surface, this is a subtle impact, but to students learning new knowledge and skills, context is important. If the faculty teaching the post-requisite course understands there is a difference in contexts, and works to bridge that gap, then the students may be able to make the transition, and build on their previous knowledge. If the faculty is unaware of the contextual differences, assumes there is no difference, or assumes the students can easily transition to the new context, then the students may feel lost, and act as if they had never seen the course matter before. A very common example is applying Differential, Integral, and Multivariate Calculus techniques to engineering. Many students will claim to perform well in Calculus- they believe they understand concepts and skills learned in three Calculus courses. Those same students may be hard pressed to apply their Calculus knowledge and skills to solving an Electromagnetics problem. It is not that the students do not have the Calculus skills and knowledge to solve the problem, but they do not understand the relationship between Electromagnetics and Calculus.

To answer the question of how course changes impact the curriculum and course sequence, there has to be a feedback mechanism. Shaeiwitz notes that good assessment plans form feedback loops. [149] Figure 4a shows the typical use of assessment and evaluation plans for a single course. The data gathered is feedback from the course. Figure 4b

illustrates how expanding evaluation (or assessment) to cover multiple classes, or a program, will yield data at multiple points. These points are typically thought of as being at the end of the semester, but using CATs and other tools, data can be gathered at any point in the semester. This data can be used as feedback to the prerequisite course (Figure 4c). The data can be gathered through pre-tests, of pre-requisite course knowledge and skills, in post-requisite courses. For example, students enrolled in CPRE211 would be given a test the first week. This test would cover selected course topics from CPRE210 that have been identified as key knowledge and skills for CPRE211. The results of this test would provide data for the faculty teaching CPRE211, and CPRE210. For the CPRE210 faculty, this data would represent a post-course assessment that could be incorporated into CPRE210's evaluation. The for CPRE211 faculty, these pre-test results would provide a baseline of student knowledge and skills. The CRPE211 faculty could then modify educational opportunities, lectures and labs to improve student learning, based on their prior knowledge. This data would also provide the faculty teaching the courses in the sequence an opportunity to discuss course changes and fit.

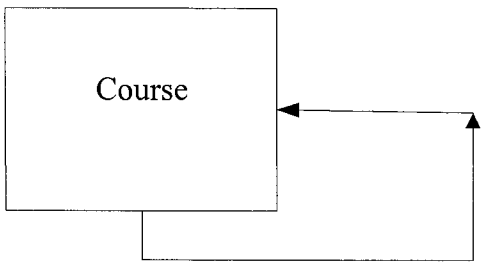

Fig 4a: Single Course using assessment data

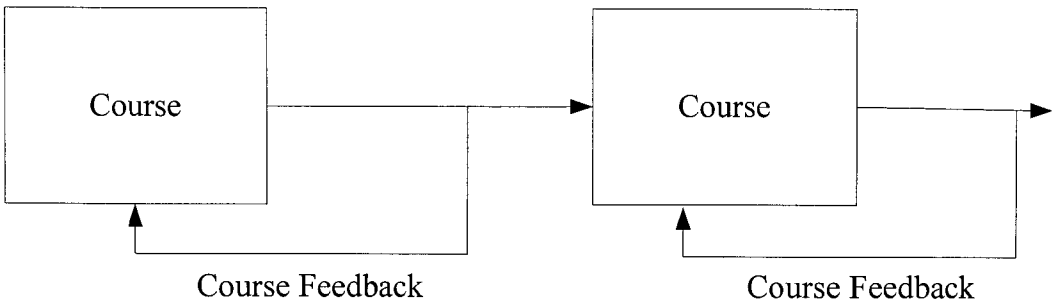

Fig 4b: Sequence of courses using assessment data individually

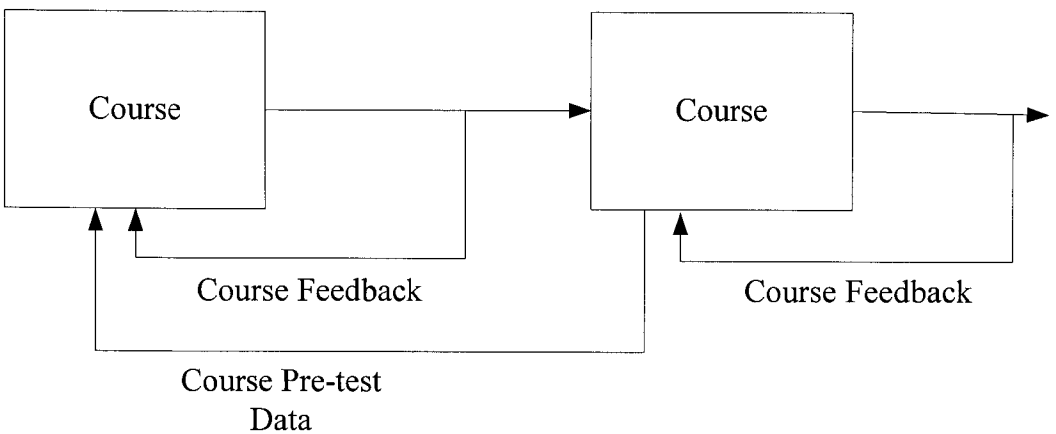

Fig 4c: Sequence of courses using assessment data together

Using the tool for identifying and measuring prerequisite course outcomes that support key course outcomes in sequence. In preparing for ABET Accreditation visits, departments usually create an Outcomes Matrix, that identifies which courses outcomes satisfy which departmental outcomes. It is not as clear which pre-requisite course outcomes support outcomes in post-requisite courses. For example, it is easy to articulate which outcomes from EE185 support EE186- these are the EELC courses. It is harder to articulate which EE185 and EE186 outcomes support EE201 or EE203. The faculty teaching the pre-requisite and post-requisite courses could discuss the outcomes for their respective courses, and conclude which outcomes from the pre-requisite course support the outcomes for the post-requisite course. These discussions would allow the faculty to identify the outcomes, but not how well the students understand the knowledge and skills in the post-requisite course context. Once the specific pre-requisite outcomes are identified, the faculty can create educational opportunities (exercises, labs, etc) and assessment activities to measure the understanding of these outcomes.

As part of the post-requisite course, measuring the understanding would incorporate a pre-test using specified knowledge and skills, learned in the pre-requisite course, to solve problems and applications introduced in the post-requisite course. Teaching and testing in the pre-requisite course would send the message to students that the material is important in the course and future courses. Testing for the same knowledge and skills in the post-requisite course would re-enforce the message from the pre-requisite course.

Expanding Figure 4b to include all departmental courses would lead to departmental-wide assessment and evaluation. The assessment data, from all the departmental courses,

would be the assessment data for the department. This would require coordination at the department level, and an Evaluation (or Assessment) Committee that would be responsible for collecting and processing the data. This new committee would not be responsible for evaluating specific courses- that would still be the responsibility of the faculty members teaching those courses, but the committee could provide assistance with building and implementing evaluation and assessment plans.

Using the ECpE Department's Outcomes Matrix as a guide, assessment data from specific courses can be used to evaluate the department's effectiveness in meeting its outcomes. The department uses numerous measures to assess effectiveness, and using data from an expanded evaluation plan would only strengthen the department's efforts. The department could also use this application to track changes in the effectiveness in meeting departmental outcomes by student cohorts, through various courses. As students develop a deeper understanding of concepts, and develop higher-level cognitive skills, the department should be able to measure those changes.

Lastly, the tool can be modified to collect longitudinal data on course and program changes. This would involve expanding the evaluation process illustrated in Figure 4c, to include all courses in the department. Where appropriate, post-requisite courses would be provide feedback to faculty members teaching pre-requisite courses. This structure would allow for changes to be tracked through the program.

APPENDIX A. CURRENT DEPARTMENTAL SURVEYS

LABORATORY EVALUATION
ELECTRICAL AND COMPUTER ENGINEERING

To the student: Using each question as a guide, fill in the circle which represents your response to each question. Please mark with a soft BLACK PENCIL.

DEPT NAME	COURSE NUMBER	SECTION	LAB INSTUCTOR'S NAME	SEMESTER	YEAR
ECPE	CprE/EE				

1. Knowledge of subject.
   - 5 Appears to possesses good knowledge of subject.
   - 3 Occasionally displays limited knowledge of subject matter.
   - 1 Often gives impression of inadequate knowledge of subject matter.

2. Oral communication.
   - 5 Able to get across ideas in an effective manner.
   - 3 Sometimes fails to get point across.
   - 1 Seldom communicates ideas clearly.

   NOTE: A=1=LOWEST E=5=HIGHEST

3. Proficiency in spoken English.
   - 5 Very clear pronunciation and use of language.
   - 3 Occasionally unclear, words mispronounced, hurried speech, moderately strong accent that limits clarity.
   - 1 Generally unclear, many words mispronounced or misused, poorly structured sentences or phrases, accents that eliminate clarity.

4. Effectiveness of written English.
   - 5 Clear and understandable.
   - 3 Satisfactory.
   - 1 Unclear.

5. Promptness in grading.
   - 5 Returned work promptly.
   - 3 Occasionally returned work late.
   - 1 Seldom returned work promptly.

6. Fairness in grading.
   - 5 Graded fairly.
   - 3 Occasionally graded unfairly.
   - 1 Seldom graded fairly.

7. Usage of instructional materials and equipment.
   - 5 Always knowledgeable.
   - 3 Usually knowledgeable.
   - 1 Frequently unknowledgeable.

8. Organization of presentations.
   - 5 Well organized.
   - 3 Adequately organized.
   - 1 Frequently not organized.

9. Availability.
   - 5 Normally available.
   - 3 Sometimes available.
   - 1 Seldom available.

10. Approachability.
    - 5 Always.
    - 3 Usually.
    - 1 Seldom.

11. Helpfulness.
    5 Always.
    3 Usually.
    1 Never.

12. Overall effectiveness of the teaching was:
    5 Very effective.
    3 Sometimes effective.
    1 Seldom effective.

PLEASE USE THE BACK OF THIS FORM TO ANSWER ADDITIONAL QUESTIONS, TO AMPLIFY ANSWERS GIVEN, AND TO ADD ADDTITIONAL COMMENTS.

Did the laboratory exercises help you learn key concepts?

Are the laboratory exercises coordinated with the class, in terms of timing and content?

Did the laboratory TA enhance your learning experience in the lab?

LECTURE EVALUATION
ELECTRICAL AND COMPUTER ENGINEERING

To the student: Student evaluation of classroom teaching is an important component of the total evaluation of the teaching effectiveness in the College of Engineering. It is therefore, an important part of your responsibility as a student to give reasoned opinions to the items below. Your response will be considered more carefully if it is provided in a professional and constructive manner.

These forms with summary results will not be returned to the instructor until after final grades for the course have been submitted.

Please mark you answers in the mark sense areas with a soft black PENCIL Ink marks will not be read by the scanner.

DEPT NAME	COURSE NUMBER	SECTION	LECTURE INSTRUCTOR'S NAME	SEMESTER	YEAR
ECPE	CprE/EE CIRCLE ONE				

Text and Course:

1. The text materials for this course were:
   1: Too elementary 2: Too difficult 3: Satisfactory
2. The pace of this course was:
   1: Too slow 2: Too fast 3: Satisfactory
3. The objectives of this course were:
   1: Not stated 2: Not attained 3: Attained
4. The catalog prerequisites for this course were appropriate.
   1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree
5. The exams were fair.
   1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree

Instructor: NOTE: 1=A=POOR 5=E=EXCELLENT
For questions 6-15, use the following 1-5 scale.

1: Poor	2: Marginally Satisfactory	3: Satisfactory	4: Good	5: Excellent

6. The instructor's ability to communicate in a clear and understandable manner was:
7. The apparent level of the instructor's knowledge of the subject was:
8. The enthusiasm demonstrated by the instructor for teaching the class was:
9. The degree of organization exhibited by the instructor was:
10. The instructor's use of class time was:
11. The extent to which the instructor created a positive learning environment in which you felt comfortable was:
12. The instructor's ability to hold your attention was:
13. The fairness shown by the instructor was:
14. The instructor's availability outside of class was: Answer only if you have direct knowledge.
15. The overall teaching effectiveness for this instructor was:

Additional Evaluation:

16. The credit hours for this course were appropriate to the effort required.
    1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree
17. The catalog description and course syllabus were followed.
    1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree
18. Equipment and support resources were adequate.
    1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree
19. Real time commitment expected of the student outside class in hrs/week.
    1: 0-2 2: 3-5 3 6-8 4: 9-11 5: 12 or more
20. This instructor motivated and inspired me to learn about this subject beyond the material required for this course.
    1: Strongly disagree 2: Disagree 3: Neutral 4. Agree 5. Strongly agree

PLEASE USE THE BACK OF THIS FORM TO ANSWER ADDITIONAL QUESTIONS, TO AMPLIFY ANSWERS GIVEN, AND TO ADD ADDTITIONAL COMMENTS.

How can coordination between Lecture and Laboratory be improved?

What topics/areas should receive more or less emphasis?

MORE:

LESS:

APPENDIX B. LEARNING COMMUNITY SURVEYS

CELTS Learning Community Survey

Please answer the following questions regarding your participation, perceptions, and experiences in this learning community this semester. Your feedback will help us to provide a high quality educational experience.

The questions below are related to how you feel about the CELTS environment:

1. Do you live on one of the CELTS Houses in Friley Hall?

Yes **No**

2. Do you feel connected to this Learning Community?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

3. Do you feel connected to the other students in CELTS?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

4. Do you feel you have made the transition to college life?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please explain:

5. Has CELTS aided you in making that transition?

Please explain:

6. Do you feel CELTS has provided you with academic support?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please Explain:

7. Do you feel that you are learning what it is to be a Computer Engineer?

Yes No
Please Explain:

The questions below relate to education opportunities you have had with CELTS. Please rate on a 1-to-5 scale the opportunities you have had to:

8. Learn about basic Computer Engineering projects

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

9. Practice and learn team work skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

10. Meet Computer Engineering Faculty and see Facilities

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

11. Practice problem solving, critical thinking and ethical reasoning skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

12. Understand Study Skills and Learning Styles

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

13. Practice presentation skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

14. Will you continue to be a part of CELTS next semester? Why/Why not?

15. Are you planning to continue studying Computer Engineering next semester?

16. Has CELTS helped you decide?

17. What have you liked about CELTS?

18. What have you disliked about CELTS?

19. What would you change about CELTS?

20. What would you keep the same?

CELTS Learning Community Coordinator Survey

Please answer the following questions regarding your participation, perceptions, and experiences in this learning community this semester. Your feedback will help us to provide a high quality educational experience.

The questions below are related to how you feel about the CELTS environment:

1. Do you feel that the Community has done enough to give students the opportunity to feel connected to this Learning Community?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

2. Do you think the students feel connected to the other students in CELTS?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

3. Do you feel that CELTS has provided students with academic support?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please Explain:

4. Have you given students the opportunity to learn what it is to be a Computer Engineer?

Yes No
Please Explain:

The questions below relate to education opportunities you have had with CELTS. Please rate on a 1-to-5 scale the opportunities you have had to:

5. Learn about basic Computer Engineering projects

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

6. Practice and learn team work skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

7. Meet Computer Engineering Faculty and see Facilities

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

8. Practice problem solving, critical thinking and ethical reasoning skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

9. Understand Study Skills and Learning Styles

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

10. Practice presentation skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

Electrical Engineering Learning Community Survey

Please answer the following questions regarding your participation, perceptions, and experiences in this learning community this semester. Your feedback will help us to provide a high quality educational experience.

The questions below are related to how you feel about the EELC environment:

1. Are you a member of the EELC?

Yes **No**

2. Do you feel connected to this Learning Community?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

3. Do you feel connected to the other students in EELC?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

4. Do you feel you have made the transition to college life?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please explain:

5. Has this learning community aided you in making that transition?
Please explain:

6. Do you feel the learning community has provided you with academic support?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please Explain:

7. Do you feel this learning community is aiding you in learning what it is to be a Electrical Engineer?

Yes No
Please Explain:

The questions below relate to education opportunities you have had with EELC. Please rate on a 1-to-5 scale the opportunities you have had to:

8. Learn about basic Mathematical principles necessary for Electrical Engineering (Matrices, Linear Interpolation, etc)

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

9. Participate in activities that require teamwork

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

10. Learn and understand basic Electrical Engineering concepts (Ohm's Law, Circuit Elements, Law of Induction, basic calculations of current, power, etc)

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

11. Learn and practice problem solving skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

12. Learning basic C Programming and Matlab skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

13. Practice presentation skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

14. Understand basic principles of how Television, Radio, Tesla Coils and Ring Launchers work?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

15. Are you planning to continue studying Electrical Engineering next semester? Why/Why not?

16. If you are a part of EELC, will you continue to participate next semester? Why/Why not?

17. What have you liked about EELC?

18. What have you disliked about EELC?

19. What would you change about EELC?

20. What would you keep the same?

Electrical Engineering Learning Community Coordinator Survey

Please answer the following questions regarding your participation, perceptions, and experiences in this learning community this semester.
The questions below are related to how you feel about the EELC environment:

1. Do you feel the Community has done enough to give students the opportunity to feel connected to this Learning Community?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

2. Do you think the students feel connected to the other students in EELC?

5	4	3	2	1
Excellent	Good	Fair	Poor	Not at all

Please explain:

3. Do you feel EELC has provided students with academic support?

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Please Explain:

4. Have you given students the opportunity to learn what it is to be an Electrical Engineer?

Yes No
Please Explain:

The questions below relate to education opportunities with EELC. Please rate on a 1-to-5 scale the opportunities you created for students to:

5. Learn about basic Mathematical principles necessary for Electrical Engineering (Matrices, Linear Interpolation, etc)

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

Participate in activities that require teamwork

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

6. Learn and understand basic Electrical Engineering concepts (Ohm's Law, Circuit Elements, Law of Induction, basic calculations of current and power, etc)

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

7. Learn and practice problem solving skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

8. Learn basic C Programming and Matlab Skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

9. Practice presentation skills

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

10.Understand basic principles of how Television, Radio, Tesla Coils and Ring Launchers work

5	4	3	2	1
Excellent	Good	Fair	Poor	Do not know

Comments:

APPENDIX C. LEARNING COMMUNITY DATA AND RESULTS

Fall 2002 CELTs Survey Data

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
1	0	3	4	4	1	5	1	3	4	3	4	3	3	1	1	0
2	1	4	5	5	1	4	1	5	5	5	5	4	4	1	1	0
3	1	5	5	5	1	4	0	3	5	5	4	4	2	0	0	0
4	0	1	1	4	1	1	1	4	4	3	4	4	3	1	1	0
5	1	4	4	5	1	3	1	2	3	4	4	4	1	1	1	1
6	0	3	3	3	0	4	1	5	3	4	4	2	3	1	1	1
7	1	4	4	4	0	3	1	3	3	2	5	3	3	1	1	1
8	1	4	3	4	0	3	1	3	4	4	3	2	1	1	1	1
9	0	4	4	4	1	3	1	4	4	3	5	4	3	1	1	0
10	0	4	3	4	1	4	1	4	3	3	3	2	2	1	1	0
11	0	1	3	3	1	2	1	3	3	3	3	3	2	1	1	0
12	0	1	2	4	1	1	1	1	1	3	2	1	1	1	1	0
13	1	3	4	3	0	2	1	2	2	2	3	3	2	1	1	0
14	1	4	4	4	1	4	1	1	1	3	4	3	3	1	1	0
15	1	4	4	4	0	4	1	4	3	3	4	3	3	0	0	0
16	1	4	4	5	1	4	1	4	4	3	3	4	3	0	1	0
17	1	3	3	4	0	4	1	4	4	4	4	3	2	1	1	0
18	1	4	3	3	1	4	1	3	3	3	3	2	2	1	1	0
19	1	2	3	3	1	3	0	3	4	3	3	3	2	1	1	0
20	1	2	4	3	0	3	1	3	3	2	3	3	2	1	1	0
21	1	2	3	2	0	2	1	3	3	3	3	2	3	1	1	0
22	1	5	5	3	1	5	0	4	4	3	4	3	2	1	1	1
23	0	2	3	4	0	4	1	3	4	3	4	4	2	1	1	0
24	0	1	1	4	0	2	1	6	5	6	6	6	2	0	0	0
25	0	1	1	4	0	1	1	3	3	3	3	3	1	0	1	0
26	0	1	1	4	0	1	1	4	4	4	4	4	3	1	1	0
27	1	4	4	4	1	4	1	4	5	4	5	4	4	1	1	1
28	1	2	3	4	1	4	1	3	3	2	3	3	2	1	1	0
29	0	2	4	5	0	2	1	4	3	3	4	3	3	0	1	0
30	1	4	4	4	1	2	1	3	4	3	3	2	2	1	1	0
31	1	4	4	4	1	4	1	4	4	4	4	4	3	1	1	0
32	0	3	3	5	0	1	1	3	4	3	4	3	2	1	1	0
33	1	5	5	4	1	5	1	4	5	5	5	5	5	1	1	1
34	1	4	4	3	0	4	1	4	2	4	3	4	4	1	1	1
35	0	3	3	5	0	4	1	5	5	5	4	4	4	1	1	0
36	1	3	4	4	0	3	1	3	4	3	3	2	3	0	0	0
37	0	3	4	5	0	3	1	3	3	4	4	4	3	1	1	0
38	1	4	3	4	0	3	0	4	4	4	4	3	2	0	1	1
39	0	3	4	4	0	4	1	4	4	1	4	3	1	0	1	0
40	1	3	5	3	1	3	1	3	3	3	4	4	2	1	1	

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
41	1	3	2	4	1	4	1	3	2	4	4	3	2	1	1	1
42	0	1	2	4	0	1	0	2	2	2	2	2	2	0	0	0
43	0	3	3	4	0	3	1	4	4	4	4	3	1	1	1	1
44	1	3	4	5	0	4	1	1	4	3	5	4	4	1	1	0
45	0	3	4	4	0	4	0	3	3	4	3	3	3	1	1	1
46	1	3	3	5	0	4	1	1	4	3	5	4	4	1	1	0
47	0	1	1	5	0	1	1	4	4	3	4	3	1	1	1	0
48	0	4	3	4	1	4	1	5	5	3	4	4	4	1	1	1
49	1	5	4	5	1	4	1	5	4	3	4	5	4	1	1	1
50	1	4	5	4	1	4	1	3	4	3	3	3	2	1	1	0
51	1	5	5	5	1	5	1	5	5	5	5	5	3	1	1	1
52	0	3	4	5	0	3	1	3	4	4	3	2	2	1	1	0
53	1	3	3	4	1	3	1	4	3	3	4	4	1	1	1	1
54	1	3	3	4	1	3	1	4	3	3	3	2	2	1	1	0
55	0	2	4	5	0	3	1	3	3	3	3	3	3	1	1	1
56	1	5	5	5	1	5	1	4	4	5	4	4	4	1	1	1
57	0	1	1	4	0	2	1	2	2	2	2	2	2	1	1	0
58	1	3	4	4	1	4	1	4	4	4	4	3	3	1	1	0
59	1	3	2	4	0	1	1	1	1	1	1	1	1	1	1	0

Fall 2003 CELTs Survey Data

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
1	1	1	4	4	0	3	1	2	5	3	4	5	2	1	1	0
2	1	3	3	4	0	4	1	3	3	3	4	3	2	0	0	0
3	0	3	3	5	0	4	0	2	3	2	4	3	2	1	1	0
4	0	2	2	4	0	3	1	4	3	3	4	4	3	0	0	1
5	0	4	4	4	1	4	1	5	4	4	5	4	3	1	1	1
6	0	3	2	2	0	4	1	4	5	4	5	4	4	1	1	1
7	1	2	4	4	0	3	1	4	3	4	3	3	3	1	1	0
8	1	4	4	5	1	4	1	4	4	5	4	4	4	1	1	1
9	1	3	4	5	0	3	0	4	1	3	4	1	1	1	1	0
10	1	3	3	5	0	4	1	3	3	3	2	2	2	1	1	0
11	1	4	3	4	1	4	1	4	4	3	3	3	3	1	1	0
12	1	4	4	4	0	1	1	5	5	1	1	4	1	1	1	0
13	1	3	1	4	1	2	0	4	3	3	4	4	2	1	1	0
14	1	3	3	4	0	3	0	4	4	3	4	4	1	1	1	0
15	0	2	1	4	0	1	0	2	2	2	2	3	2	0	0	0
16	1	3	4	3	1	4	1	4	4	1	4	1	1	1	1	1
17	0	3	3	4	1	3	1	4	4	4	4	4	3	1	1	0
18	1	4	4	4	0	4	1	4	3	4	4	3	2	1	1	0
19	1	3	2	4	0	4	1	4	5	4	5	4	4	1	1	1
20	0	2	3	4	0	3	1	3	4	3	4	3	2	0	1	0
21	0	4	4	5	1	4	1	3	4	4	4	4	3	1	1	0
22	0	2	3	3	0	3	1	3	2	3	3	3	2	1	1	0
23	1	3	4	4	0	3	1	4	4	3	3	4	2	1	1	0
24	0	2	4	4	1	3	1	3	3	3	4	3	2	1	1	0
25	0	3	3	5	1	4	1	4	4	3	3	3	1	0	0	1
26	0	1	1	4	0	3	1	3	2	3	4	3	2	0	1	0
27	1	3	3	4	1	4	1	3	2	4	5	4	4	1	1	0
28	1	3	4	4	1	3	1	4	4	3	4	4	2	1	1	0
29	1	3	3	4	1	3	1	4	4	4	4	4	4	1	1	1
30	1	2	2	3	1	5	1	5	4	4	3	4	3	1	1	1
31	1	5	3	4	1	3	1	3	3	4	4	3	2	1	1	1
32	1	4	5	4	0	3	1	3	4	4	5	3	1	1	1	0
33	1	4	4	5	1	4	1	5	3	4	4	5	3	0	0	0
34	1	4	3	5	1	3	1	4	4	3	4	3	3	1	1	0
35	1	5	5	5	1	5	1	5	5	5	5	5	5	1	1	1
36	1	3	3	3	1	3	1	3	3	3	3	2	3	1	1	0
37	0	3	3	3	1	4	1	4	3	3	4	4	3	1	1	1
38	0	3	4	4	0	1	1	4	5	3	4	5	2	1	1	1
39	0	4	4	4	1	4	1	4	4	4	4	3	3	1	1	0
40	1	3	3	2	0	2	0	2	3	4	2	2	3	0	1	0

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
41	0	3	4	5	1	3	1	4	4	3	3	3	3	0	0	0
42	0	1	2	1	0	1	1	1	2	1	1	1	1	0	0	0
43	0	3	4	5	0	3	1	4	2	3	4	3	2	1	1	0
44	0	3	3	4	0	3	1	3	1	3	4	4	3	1	1	1
45	0	2	2	4	1	3	1	3	3	4						
46	1	4	4	3	1	3	1	4	4	3	4	3	3	1	1	1
47	0	3	4	4		3	1	4	4	1	3	3	1	1	1	
48	1	3	3	4	1	4	1	4	3	4	5	4	3	1	1	1
49	1	3	3	3	0	4		1	1	1				1	1	
50	1	4	4	4	1	4	1	3	4	5	5	5	3	0	0	0
51	0	5	5	5	1	1	0	2	2	2	4	2	2	1	1	0
52	1	3	4	4	0	4	1	3	3	4	3	4	4	1	1	1
53	0	2	3	3	0	1	1	4	4	4	4	3	3	0	1	0
54	1	4	5	4	1	4	1	3	5	3	4	2	2	1	1	1
55	1	3	3	4	0	3	1	4	4	4	3	4	3	1	1	
56	0	2	3	4	1	4	0	3	3	3	3	3	2	0	0	0
57	0	1	2	3	1	4	1	3	4	3	4	3	2	0	1	
58	1	3	3	5	0	3	1	3	4	4	4	4	2	1	1	0
59	1	4	4	4	1	3	0	4	4	4	4	4	3	1	1	1
60	1	4	4	4	1	3	1	4	4	3	3	3	2		1	
61	1	4	4	5	0	4	0	1	3	3	4	2	2	1	1	0
62	0	3	2	4	1	1		3	3	3	3	3	3	1	1	1
63	1	3	4	4	1	4	0	3	4	3	3	3	2	0	0	
64	0	1	2	4	0											
65	1	2	3	4	0	2	0	3	2	3	2	3	2	0	1	0
66	0	1	1	5	0		1	3	2	3	4	3	3	1	1	
67	0	1	2	5	0	2	1	1	3	3				1	1	0
68	0	3	3	4	0	4	1	4	4	3	4	4	4	1	1	1
69	1	4	4	5	0	3	1	4	4	4	4	4	2	1	1	0

Fall 2002 EELC Survey Data

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
1	1	3	3	4	1	4	1	4	4	4	4	4	3	4	1	1
2	1	3	4	2	1	3	1	5	3	4	5	3	3	3	1	1
3	0		4	3	1	4	1	4	4	3	4	4	3	4	1	
4	1	3	3	3	1	3	1	3	3	2	4	4	2	3	0	0
5	1	3	3	4	0	3	0	3	3	3	4	3	3	3	0	0
6	1	4	4	4	1	4	1	4	3	3	4	4	3	3	1	0
7	1	3	3	3	1	4	1	3	4	3	3	3	3	4		
8	1	4	4	4	1	4	1	4	3	4	4	4	3	4	1	1
9	1	5	5	5	1	5	1	5	5	5	5	5	4	5	1	1
10	1	4	4	4	1	4	1	4	4	4	4	5	4	4	1	1
11	1	4	5	4	1	4	1	4	4	4	4	4	4	4	1	1
12	1	2	4	3	0	4	1	4	4	3	4	5	2	5	1	0
13	1	3	3	4	1	4	1	4	4	4	5	4	3	5	1	
14	1	3	4	3	1	3	1	3	4	4	5	3	3	4	1	1
15	1	2	2	4	1	3	1	3	3	3	5	3	2	3	1	0
16	1	4	1	4	1	4	1	4	4	4	5	5	2	4	1	1
17	1	4	4	4		3	1	3	4	4	5	3	3	4	1	

Fall 2002 CELTS Survey Statistics

Group Statistics

	q1	N	Mean	Std. Deviation	Std. Error Mean
q2	0	24	2.25	1.113	.227
	1	35	3.63	.910	.154
q3	0	24	2.75	1.189	.243
	1	35	3.83	.857	.145
q4	0	24	4.21	.588	.120
	1	35	4.00	.767	.130
q5	0	24	.29	.464	.095
	1	35	.66	.482	.081
q6	0	24	2.63	1.313	.268
	1	35	3.54	.919	.155
q7	0	24	.92	.282	.058
	1	35	.89	.323	.055
q8	0	24	3.42	.974	.199
	1	35	3.34	1.027	.174
q9	0	24	3.38	.970	.198
	1	35	3.57	1.065	.180
q10	0	24	3.17	.816	.167
	1	35	3.40	.976	.165
q11	0	24	3.50	.780	.159
	1	35	3.77	.877	.148
q12	0	24	3.00	.834	.170
	1	35	3.31	.993	.168
q13	0	24	2.33	.917	.187
	1	35	2.66	1.083	.183
q14	0	24	.79	.415	.085
	1	35	.86	.355	.060
q15	0	24	.92	.282	.058
	1	35	.91	.284	.048
q16	0	24	.21	.415	.085
	1	35	.40	.497	.084

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
q2	Equal variances assumed	3.641	.061	-5.217	57	.000	-1.379	.264	-1.908	-.849
	Equal variances not assumed			-5.024	42.835	.000	-1.379	.274	-1.932	-.825
q3	Equal variances assumed	4.766	.033	-4.053	57	.000	-1.079	.266	-1.611	-.546
	Equal variances not assumed			-3.817	38.968	.000	-1.079	.283	-1.650	-.507
q4	Equal variances assumed	.165	.687	1.122	57	.266	.208	.186	-.163	.580
	Equal variances not assumed			1.179	56.208	.243	.208	.177	-.146	.562
q5	Equal variances assumed	.693	.409	-2.905	57	.005	-.365	.126	-.617	-.114
	Equal variances not assumed			-2.925	50.764	.005	-.365	.125	-.616	-.115
q6	Equal variances assumed	8.084	.006	-3.164	57	.002	-.918	.290	-1.499	-.337
	Equal variances not assumed			-2.964	38.132	.005	-.918	.310	-1.545	-.291
q7	Equal variances assumed	.592	.445	.380	57	.705	.031	.081	-.132	.194
	Equal variances not assumed			.390	53.587	.698	.031	.079	-.128	.190
q8	Equal variances assumed	.026	.874	.277	57	.783	.074	.267	-.460	.608
	Equal variances not assumed			.280	51.277	.781	.074	.264	-.456	.604

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
q9	Equal variances assumed	.179	.674	-.721	57	.474	-.196	.272	-.742	.349
	Equal variances not assumed			-.734	52.495	.466	-.196	.268	-.733	.340
q10	Equal variances assumed	2.458	.122	-.962	57	.340	-.233	.243	-.719	.252
	Equal variances not assumed			-.995	54.660	.324	-.233	.235	-.703	.237
q11	Equal variances assumed	.027	.871	-1.220	57	.228	-.271	.222	-.717	.174
	Equal variances not assumed			-1.247	53.148	.218	-.271	.218	-.708	.165
q12	Equal variances assumed	2.440	.124	-1.272	57	.209	-.314	.247	-.809	.180
	Equal variances not assumed			-1.314	54.572	.194	-.314	.239	-.794	.165
q13	Equal variances assumed	.811	.372	-1.199	57	.236	-.324	.270	-.865	.217
	Equal variances not assumed			-1.237	54.389	.221	-.324	.262	-.849	.201
q14	Equal variances assumed	1.658	.203	-.650	57	.519	-.065	.101	-.267	.136
	Equal variances not assumed			-.631	44.339	.531	-.065	.104	-.275	.144
q15	Equal variances assumed	.004	.950	.032	57	.975	.002	.075	-.148	.153
	Equal variances not assumed			.032	49.782	.975	.002	.075	-.148	.153
q16	Equal variances assumed	10.870	.002	-1.553	57	.126	-.192	.123	-.439	.055
	Equal variances not assumed			-1.607	54.708	.114	-.192	.119	-.431	.047

Fall 2002 EELC Survey Statistics

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
q2	16	3.38	.806	.202
q3	17	3.53	1.007	.244
q6	17	3.71	.588	.143
q9	17	3.71	.588	.143
q10	17	3.59	.712	.173
q11	17	4.35	.606	.147
q12	17	3.88	.781	.189
q14	17	3.88	.697	.169

One-Sample Test

	Test Value = 4					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
q2	-3.101	15	.007	-.625	-1.05	-.20
q3	-1.926	16	.072	-.471	-.99	.05
q6	-2.063	16	.056	-.294	-.60	.01
q9	-2.063	16	.056	-.294	-.60	.01
q10	-2.384	16	.030	-.412	-.78	-.05
q11	2.400	16	.029	.353	.04	.66
q12	-.621	16	.543	-.118	-.52	.28
q14	-.696	16	.496	-.118	-.48	.24

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
q8	17	3.76	.664	.161

One-Sample Test

	Test Value = 5					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
q8	-7.668	16	.000	-1.235	-1.58	-.89

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
q13	17	2.94	.659	.160

One-Sample Test

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
q13	-.368	16	.718	-.059	-.40	.28

Fall 2003 CELTs Survey Statistics

Group Statistics

	q1	N	Mean	Std. Deviation	Std. Error Mean
q2	0	30	2.50	1.042	.190
	1	39	3.33	.806	.129
q3	0	30	2.87	1.042	.190
	1	39	3.51	.823	.132
q4	0	30	3.97	.928	.169
	1	39	4.05	.686	.110
q5	0	29	.45	.506	.094
	1	39	.51	.506	.081
q6	0	28	2.89	1.133	.214
	1	39	3.38	.815	.130
q7	0	28	.86	.356	.067
	1	38	.79	.413	.067
q8	0	29	3.24	.951	.177
	1	39	3.54	.942	.151
q9	0	29	3.21	1.013	.188
	1	39	3.56	.968	.155
q10	0	29	3.00	.802	.149
	1	39	3.41	.938	.150
q11	0	27	3.67	.832	.160
	1	38	3.68	.933	.151
q12	0	27	3.26	.764	.147
	1	38	3.39	1.028	.167
q13	0	27	2.44	.801	.154
	1	38	2.53	.979	.159
q14	0	28	.64	.488	.092
	1	38	.84	.370	.060
q15	0	28	.79	.418	.079
	1	39	.90	.307	.049

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
q2	Equal variances assumed	3.117	.082	-3.748	67	.000	-.833	.222	-1.277	-.390
	Equal variances not assumed			-3.625	53.210	.001	-.833	.230	-1.294	-.372
q3	Equal variances assumed	1.530	.220	-2.879	67	.005	-.646	.224	-1.094	-.198
	Equal variances not assumed			-2.793	54.033	.007	-.646	.231	-1.110	-.182
q4	Equal variances assumed	1.004	.320	-.436	67	.665	-.085	.194	-.472	.303
	Equal variances not assumed			-.419	51.573	.677	-.085	.202	-.490	.321
q5	Equal variances assumed	.333	.566	-.520	66	.605	-.065	.124	-.312	.183
	Equal variances not assumed			-.520	60.498	.605	-.065	.124	-.313	.184
q6	Equal variances assumed	2.114	.151	-2.068	65	.043	-.492	.238	-.967	-.017
	Equal variances not assumed			-1.961	46.236	.056	-.492	.251	-.997	.013
q7	Equal variances assumed	2.044	.158	.696	64	.489	.068	.097	-.126	.262
	Equal variances not assumed			.712	62.343	.479	.068	.095	-.122	.258
q8	Equal variances assumed	.000	.998	-1.281	66	.205	-.297	.232	-.760	.166
	Equal variances not assumed			-1.280	60.159	.206	-.297	.232	-.761	.167

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
q9	Equal variances assumed	.333	.566	-1.475	66	.145	-.357	.242	-.841	.126
	Equal variances not assumed			-1.465	58.893	.148	-.357	.244	-.845	.131
q10	Equal variances assumed	2.764	.101	-1.895	66	.062	-.410	.216	-.842	.022
	Equal variances not assumed			-1.940	64.652	.057	-.410	.211	-.833	.012
q11	Equal variances assumed	.660	.420	-.078	63	.938	-.018	.225	-.467	.431
	Equal variances not assumed			-.080	59.717	.937	-.018	.220	-.458	.423
q12	Equal variances assumed	4.263	.043	-.580	63	.564	-.135	.234	-.602	.331
	Equal variances not assumed			-.609	62.839	.544	-.135	.222	-.580	.309
q13	Equal variances assumed	1.261	.266	-.358	63	.722	-.082	.229	-.539	.376
	Equal variances not assumed			-.370	61.677	.713	-.082	.221	-.524	.361
q14	Equal variances assumed	13.333	.001	-1.889	64	.063	-.199	.105	-.410	.011
	Equal variances not assumed			-1.812	48.343	.076	-.199	.110	-.420	.022
q15	Equal variances assumed	6.483	.013	-1.262	65	.211	-.112	.089	-.289	.065
	Equal variances not assumed			-1.201	47.010	.236	-.112	.093	-.299	.075

BIBLIOGRAPHY

1. Learning Community Assessment Subcommittee, *Guidelines for Best Practice in Learning Community Assessment*, Iowa State University, March 2002, www.iastate.edu/~learncommunity/guidelines.html. (accessed 4/20/03)

2. MacGregor, Jean, Tinto, Vincent, Lindblad, Jerri Holland, "Assessment of Innovative Efforts: Lessons from the Learning Community Movement", In L. Suskie (ed), *Assessment to Promote Deep Learning: Insight from AAHE's 2000 and 1999 Assessment Conferences*, American Association of Higher Education, Washington, DC, 2001, pp. 41-49.

3. Lenning, Oscar T., Ebbers, Larry H., *The Powerful Potential of Learning Communities: Improving Education for the Future*. ASHE-ERIC Higher Education Report Vol. 26, Number 6, Washington, DC, The George Washington University, Graduate School of Education and Human Development, 1999, p.10.

4. Ibid, p.8.

5. Learning Community Assessment Subcommittee, *Learning Community Assessment: Milestones on the Road less Traveled*, 2002-03 Report from the Learning Community Assessment Subcommittee, Iowa State University Learning Community Institute, May 2003. http://www.iastate.edu/~learncommunity /2003AssessmentPlenary.pdf (accessed 1/08/04).

6. Learning Community Assessment Subcommittee, 2002-03 Report.

7. LC Curriculum Development and Enhancement Subcommittee

8. Lenning, Oscar T., Ebbers, Larry H., p. 40.

9. Ibid, p.45.

10. Ibid., p. 44.

11. Office of Institutional Research, ISU Fact Book 2002-2003, Iowa State University, 2003. http://www.iastate.edu/%7Einst_res_info/factbk.html (accessed September 21, 2003).

12. Lenning, Oscar T., Ebbers, Larry H., p. 60.

13. Learning Community Assessment Subcommittee, 2002-03 Report.

14. Office of Institutional Research, *ISU Factbook 2003-04*, Iowa State University, 2004. http://www.iastate.edu/%7Einst_res_info/factbk.html (access 7/01/04).

15. Learning Community Assessment Subcommittee, 2002-03 Report.

16. Ibid.

17. Epperson, Douglas L., *Report on One-Year and Two-Year University Retention Rates Associated with First-Year Participation in a Learning Community at ISU*, Iowa State University, 2001. http://www.iastate.edu/~learncommunity/templates/retentionf00.pdf (accessed 4/20/03)

18. Learning Community Assessment Subcommittee, 2002-03 Report.

19. Ibid.

20. Ibid.

21. Ibid.

22. Ibid.

23. Ibid.

24. 2004 USNWR Annual College Rankings

25. Hutchings, Pat, Smith, Barbara Leigh, Iowa State University Site Report, March 2003. http://www.iastate.edu/~learncommunity/consultantsreport.doc (accessed 1/10/04).

26. Ibid.

27. Ibid.

28. Huba, Mary E., Freed, Jann E., *Learner-Centered Assessment on College Campuses- Shifting the Focus from Teaching to Learning*, Allyn and Bacon, Boston, 2000, pp. 8-9.

29. Rogers, Gloria M., Sando, Jean K., *Stepping Ahead: An Assessment Plan Development Guide*, Rose-Hulman Institute of Technology, Terre Haute, 1996.

30. Shaeiwitz, Joseph A., "Outcomes Assessment in Engineering Education", Journal of Engineering Education, Vol. 85, Number 3 July 1996, pp. 239- 246.

31. Ibid.

32. Borden, Victor M. H., "A Few Good Measures: The Impossible Dream?", In L. Suskie (ed), *Assessment to Promote Deep Learning: Insight from AAHE's 2000 and 1999 Assessment Conferences*, American Association of Higher Education, Washington, DC, 2001, pp.31-40.

33. Beagles, Charles A, Griffin, Steven L., "Visibility into the Work: TQM Work Process Analysis with HPT and ISD", Performance Improvement Journal, Vol. 42 Number 2 February 2003, pp.16-18.

34. Ibid.

35. Sallis, Edward, *Total Quality Management in Education*, 3rd Edition, 2002, Kogan Page Ltd, London, p.24

36. Worthen, Blaine R., Sanders, James R., Fitzpatrick, Jody L., *Program Evaluation-Alternative Approaches and Practical Guidelines*, 2nd Edition, Addison Wesley Longman, p.521

37. The Joint Taskforce on Engineering Education Assessment, *Assessment White Paper-A Framework for the Assessment of Engineering Education*, American Society for Engineering Education, June 1996.

38. ASEE Assessment White Paper

39. Ibid.

40. Sallis, p. 28.

41. Ibid, p. 22.

42. Ibid, p. 28.

43. Ewell, Peter T., "National Trends in Assessing Student Learning", Journal of Engineering Education, Vol. 87 Number 2 April 1998, pp.107-113.

44. Ewell, Peter T., "The Role of States and Accreditors in Shaping Assessment Practice," In T.W. Banta and Associates (ed), *Making a Difference: outcomes of a Decade of Assessment in Higher Education*, Jossey-Bass Publishers, San Francisco,1993, pp. 339-356.

45. Ewell, April 1998.

46. Ibid.

47. Burd, Stephen, "Colleges Catch a Glimpse of Bush Policy on Higher Education, and Aren't Pleased", The Chronicle of Higher Education, Vol. 48 issue 26, March 8, 2002, p.26a.

48. Ibid.

49. Ibid.

50. Ibid.

51. Ibid.

52. Borrego, Anne Marie, "Education Department to Emphasize Retention in Next Higher Education Act", The Chronicle of Higher Education, Vol. 48 issue 44, July 12, 2002, p.44a.

53. Ibid.

54. Ibid.

55. Felder, Richard M., "The Warm Winds of Change", Chemical Engineering Education, Vol. 30, Number 1 Winter 1996, pp 34-35.

56. ABET Website, www.ABET.org (accessed 1/08/04)

57. Ibid

58. Ibid

59. Iowa Professional Licensing Division, State of Iowa Website, www.state.ia.us/government/com/prof/engineer/home.html (accessed 4/30/03).

60. ABET Website

61. Ibid

62. Splitt, Frank G., "Engineering Education Reform: A Trilogy, Part II: The Challenge to Change", October 2002. http://www.ece.northwestern.edu/EXTERNAL/Splitt/ (accessed 10/01/04)

63. American Society for Engineering Education Engineering Deans Council and Corporate Roundtable, *The Green Report: Engineering for a Changing World,* American Society for Engineering Education, October 1994.

64. Wulf, William A., "The Urgency of Engineering Education Reform", The Bridge, Volume 28, Number 1- Spring 1998.

65. Felder, Richard M., "The Warm Winds of Change".

66. Splitt.

67. Johnson, Johnson, and Smith, *Active Learning: Cooperation in the College Classroom*, Interaction Book Company, Edina, 1991, pp.1:6-1:11.

68. Ibid, p.1:4.

69. Ibid, p. 1:5.

70. Ibid, p. 1:5.

71. The Boyer Commission on Educating Undergraduates in the Research University, *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*, State University of New York at Stony Brook, Stony Brook, New York, 1998.

72. Johnson, Johnson, Smith, p. 1:8.

73. Landis, Raymond B., *Studying Engineering- A Roadmap to a Rewarding Career*, 2nd Edition, Discovery Press, Los Angeles, 2000, p.2.

74. Johnson, Johnson, Smith, p. 1:10.

75. Ibid, p.1:9.

76. Smith, Karl A., "Going Deeper: Formal Small-Group Learning in Large Classes", In J. MacGregor et al (ed), Strategies for Energizing Large Classes: From Small Groups to Learning Communities, Number 81 Spring 2000, Jossey-Bass, San Francisco, 2000, pp 25-46.

77. Ibid, p. 1:10.

78. Ibid, p. 1:11.

79. Ibid, p. 1:18.

80. Ibid, p. 1:11.

81. Wulf.

82. Jackson, Shirley A., Changes and Challenges in Engineering Education. Main plenary address, ASEE Annual Conference, Nashville, Tennessee, June 23, 2003. http://www.rpi.edu/web/President/speeches/asee.html (accessed 1/08/04)

83. Splitt.

84. Wulf.

85. Jackson.

86. Splitt.

87. Ibid.

88. Noam, Eli M., "Electronics and the Dim View of the University", Science, Vol. 270, Oct 13,1995.

89. Splitt.

90. Noam.

91. ASEE, *Green Report*, 1994.

92. Ibid.

93. ABET EC2000 Criteria.

94. Felder, Richard M., Brent, Rebecca, "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria", Journal of Engineering Education, Vol. 92 Number 1 January 2003, pp.7-25.

95. ABET website.

96. Ibid.

97. Rogers, Gloria M., Sando, Jean K., *Stepping Ahead: An Assessment Plan Development Guide*, Rose-Hulman Institute of Technology, Terre Haute, 1996.

98. Wergin, Jon F., "Assessment of Programs and Units", *Architecture for Change: Information as Foundation Presentations from the 1998 AAHE Assessment Conference*, American Association of Higher Education, Washington, DC, 1999.

99. Ibid.

100. Ewell, 1998.

101. ASEE Assessment White Paper.

102. Huba and Freed, pp. 9-14.

103. MacGregor, Jean, Tinto, Vincent, Lindblad, Jerri Holland, "Assessment of Innovative Efforts: Lessons from the Learning Community Movement", In L. Suskie (ed), *Assessment to Promote Deep Learning: Insight from AAHE's 2000 and 1999 Assessment Conferences*, American Association of Higher Education, Washington, DC, 2001, pp.41-48.

104. Ibid.

105. Ibid.

106. Ibid.

107. Ibid.

108. Ibid.

109. Huba and Freed, pp. 66-85.

110. ASEE Assessment White Paper.

111. Worthen, p. 101.

112. Ibid, p. 101.

113. Ibid, pp. 158-9.

114. Worthen, p.166-7.

115. Huba and Freed p93.

116. Wiggins, Grant, McTighe, Jay, *Understanding by Design*, 1st Edition, Prentice-Hall Publishing, Upper Saddle River, 1998, p.93.

117. Huba and Freed pp.94-97.

118. Wiggins and McTighe, p 10.

119. Huba and Freed, p. 90.

120. Angelo, Thomas A., Cross, K. Patricia, *Classroom Assessment Techniques- A Handbook for College Teachers*, Jossey-Bass Publishers, San Francisco, 2nd Edition, 2003, p. 4.

121. Angelo and Cross, pp.7-11.

122. Ibid, p.5.

123. Ibid, pp 119-359.

124. Ibid, p. 119.

125. Ibid, p. 120.

126. Ibid, p. 120.

127. Ibid, p320.

128. Ibid, p. 231.

129. Ibid, p. 320.

130. Huba and Freed, pp.130-2.

131. Angelo and Cross, p. 137.

132. Besterfield-Sacre, Mary, Atman, Cynthia, Shuman, Larry, "Engineering Student Attitudes Assessment", Journal of Engineering Education, Vol. 87 Number 2 April 1998 pp.133-141.

133. Beagles and Griffin.

134. Rohan, Sue, "The Malcolm Baldrige Approach and Assessment", *Architecture for Change: Information as Foundation Presentations from the 1998 AAHE Assessment Conference*, American Association of Higher Education, Washington, DC, 1999, pp. 43-58.

135. Sallis, p.54.

136. Huba and Freed, p.130.

137. Sallis, p.19.

138. Ibid, p. 27.

139. Rohan.

140. Borden.

141. Leydens, Jon A., Moskal, Barbara M., Pavelich, Michael J., "Qualitative Methods Used in the Assessment of Engineering Education", Journal of Engineering Education, Vol. 93 Number 1 January 2004, pp. 65-72.

142. Yao, Yuankun, Weissinger, Ellen, Grady, Marilyn, "Faculty Use of Student Evaluation Feedback", Practical Assessment, Research & Evaluation, Vol. 8 Number 21 October 2003.

143. Larpkiataworn, Siripen, Muogboh, Obinna, Besterfield-Sacre, Mary, Shuman, Larry, Wolfe, Harvey, "Special Considerations using Statistical Analysis in Engineering Education Assessment and Evaluation", Journal of Engineering Education, Vol. 92 Number 3 July 2003, pp. 207-15.

144. Ibid.

145. Cordes, David, Evans, Don, Frair, Karen, Froyd, Jeff, "The NSF Foundation Coalition: The First Five Years", Journal of Engineering Education, Vol.88 Number 1 January 1999, pp. 73- 77.

146. Ewell 1998.

147. Ibid.

148. Ibid.

149. Shaeiwitz 1998.

ADDITIONAL READINGS

Sharma, Anand D., Espinosa, Ramon E. Vasquez, "Continuous Improvement Educational Initiative: A Campus-Wide Assessment Effort", *Proceedings of the 2004 American Society of Engineering Education Annual Conference and Exposition*, American Society of Engineering Education, 2004.

Karimi, Amir, Clutter, Keith, Arroyo, Alberto, "An Example of Course and Program Outcome Assessment", *Proceedings of the 2004 American Society of Engineering Education Annual Conference and Exposition*, American Society of Engineering Education, 2004.

Lyons, Jed S., Bayoumi, Abdel M., "CQI Processes, Results, and Program Improvements for Engineering Design", IEEE Transactions on Education, Vol. 43 Number 2 May 2000, pp.174-181.

Pimmel, Russell L., "Student Learning of Criterion 3(a)-(k) Outcomes with Short Instructional Modules and the Relationship to Bloom's Taxonomy", Journal of Engineering Education, Vol. 92 Number 4 October 2003, pp.351- 359.

Wiggins, Grant, "The Case for Authentic Assessment", Practical Assessment, Research & Evaluation, Vol. 2, Number 2, 1990, http://pareonline.net/getvn.asp?v=2&n=2. (accessed 10/15/04)

Marzano, Robert J., Pickering, Debra J., McTighe, Jay, *Assessing Student Outcomes- Performance Assessment using the Dimensions of Learning Model*, 1st Edition, Association for Supervision and Curriculum Development, Alexandria, 1993.

Wiggins, Grant, *Educative Assessment- Designing Assessments to Inform and Improve Student Performance*, 1st Edition, Jossey-Bass, San Francisco, 1998.

Frechtling, Joy A. (ed), *User-Friendly Handbook for Project Evaluation in Science, Mathematics, Engineering and Technology Education*, Division of Research, Evaluation and Communication, National Science Foundation, Arlington, 1993.

Schaub, Diane A., Legg, Sue M., Svoronos, Spyros A., Koopman, Ben L., Bai, Sherman X., "Applying Total Quality Management in an Interdisciplinary Engineering Course", Journal of Engineering Education, Vol.88 Number 1 January 1999, pp. 107-112.

Goodson, Carole, Faulkenberry, Luke, Miertschin, Susan, Stewart, Barbara, "Comprehensive Program Assesment: The Whys and Wherefores", *Proceedings of the 2004 American Society of Engineering Education Annual Conference and Exposition*, American Society of Engineering Education, 2004.

Moskal, Barbara M., "Recommendations for Developing Classroom Performance Assessments and Scoring Rubrics", Practical Assessment, Research & Evaluation, Vol. 8, Number 14, May 2003, (accessed 10/15/04)

Sarin, Sanjiv, "Quality Assurance in Engineering Education: A Comparison of EC-2000 and

ISO-9000", Journal of Engineering Education, Vol.89 Number 4 October 2000, pp. 495- 501.

Scoles, Kevin, Bilgutay, Nilhat, Good, Jerene, "A New Course Evaluation Process", IEEE Transactions on Education, Vol. 43, Number 2, May 2000, pp. 125- 131.

Walker, David A., "A Model of Assessing Assessment Activities", College Student Journal, Vol 33 Issue 3 September 1999, p.439.

Office of the Provost, "Assessing Assessment", University of Wisconsin-LaCrosse, www.uwlax.edu/provost/assessment/restore062103/A_assess.htm, (accessed 10/2/2004).

ACKNOWLEDGEMENTS

I would like to thank my major professor Dr. Doug Jacobson and Dr. Mani Mina for their support in this research work. Both allowed me to work with their learning communities. I would also like to thank my committee members, Dr. Jim Davis, Dr. Loren Zachary, Dr. Larry Ebbers, and Dr. George Jackson for their comments and suggestions.

I would also like to thank my wife, Tracy Allen Freeman. Without her love and support, I could not have gotten this completed. I would also like to thank my daughter, Solana Freeman, for through her, I am reminded daily what learning looks like.