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ABSTRACT

The report describes development of an alternative core curriculum of courses grounded equally in both mathematics/sciences and traditional humanities. The alternative core curriculum is based on the belief that mathematics, broadly defined, is the common language and basis for the contemporary revolutions in the physical sciences, social sciences, technology, and information sciences. The program serves students majoring in the following fields: anthropology, computer science, economics, history, philosophy, political science, psychology, and sociology. Currently an average of 33 undergraduates per semester elect the alternative courses. The program has involved development of specific core courses, development of courses in the major field programs based on the alternative core, and preliminary development of entirely new Bachelors programs based on the alternative core. Eight Bachelor of Arts degree programs based on the alternative core are now in place. Recommendations include adding two more Bachelors programs to maintain a critical mass of students and ensure the long term viability of the alternative curriculum. Separate brief reports by faculty participants in each of the new courses are included. (DB)

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FINAL REPORT

GRANTEE ORGANIZATION:

Case Western Reserve University
Cleveland, OH 44106

GRANT NO: G008730463

PROJECT DATES:

Starting Date: September 1, 1987
Ending Date: August 31, 1989
Number of Months: 24 months

PROJECT DIRECTOR:

Professor John C. Angus
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Case Western Reserve University
Cleveland, OH 44106

FIPSE PROGRAM OFFICER:

Grant Award:

Year 1	90,807
Year 2	68,364
Total	159,171

1.0 SUMMARY

A radically new liberal arts/mathematics based alternative core (LAMBDA core) was implemented and expanded under the FIPSE grant. The LAMBDA core is based on the belief that mathematics, broadly defined, is the common language and basis for the contemporary revolutions in the physical sciences, social sciences, technology and information sciences. Students completing a LAMBDA core program receive a thorough grounding in mathematics, logic and scientific methods in addition to the advantages of an education in the humanities. Course offerings and programs for the LAMBDA core were developed in the following curricular areas: Anthropology, Biology, Earth Sciences, History, Management Science, Mathematics, Philosophy, Physics, Psychology and Sociology. An average of 33 undergraduate students per semester are now taking LAMBDA courses.

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2.0 EXECUTIVE SUMMARY

Project Title: Liberal Arts/Mathematics Based Alternative Core

Grantee Organization: Case Western Reserve University
Cleveland, OH 44106

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2.1 Project Overview

A liberal arts/mathematics based alternative core curriculum (LAMBDA core) has been developed. The core curriculum is in place and serves students majoring in the following fields: Anthropology, Computer Science, Economics, History, Philosophy, Political Science, Psychology and Sociology. Currently an average of 33 undergraduates take LAMEDA core courses each semester. Principal project activities performed under FIPSE support included: 1) development of specific LAMBDA core courses; 2) development of courses in the major field BA programs which are based on the LAMBDA core and 3) preliminary development of entirely new Bachelors programs based on the LAMBDA core.

2.2 Purpose

The purpose of the project was the development of a radically new Liberal Arts/Mathematics Based Alternative Core curriculum (LAMBDA core) upon which a set of unique Bachelor degree programs could be based. The new core is as firmly based in mathematics and scientific methods of thought as it is in the humanities. It provides students with the intellectual background necessary to comprehend and participate in the contemporary revolutions in the physical sciences, social sciences, technology and communications.

2.3 Background and Origins

The Liberal Arts/Mathematics Based Alternative Core (LAMBDA core) arose out of a University Commission on Undergraduate Education that was initiated by the past university president, Dr. David V. Ragone. One of the principal recommendations of the Commission was the establishment of a new liberal arts core curriculum that was as firmly grounded in mathematics and the sciences as it was in the traditional humanities. An ad–hoc committee spent one year making a very specific recommendation of a core curricular, which was brought to the full faculty for approval. The faculty approved the LAMBDA core as an alternative to the traditional liberal arts core curriculum.

It was not necessary to change university policies in order to implement the LAMBDA core. Major institutional dislocations were avoided by making the LAMBDA core an alternative to the traditional core already in place. While this strategy was highly successful in helping to get the LAMBDA core approved, it has led to enrollment problems. Students elect to take the traditional liberal arts core, which is perceived to be a softer option.

2.4 Project Description

The principal activity during the project was the development of specific courses in support of the entire LAMBDA core activity. Some of these courses were in the LAMBDA core itself, e.g., Natural Philosophy, Mathematical Modelling and Earth Sciences. Others

were key courses in the separate BA curricular based on the LAMBDA core, e.g., Psychology and History.

In addition to the course development, the LAMBDA core committee met on a regular basis to discuss matters of overall policy and to give direction, when needed, to the faculty developing the courses.

Other ancillary activities included attendance at appropriate professional society meetings and service as internal consultants to faculty not actively involved in the LAMBDA core.

2.5 Project Results

The project was highly successful, although much more remains to be accomplished to insure the long-term viability of the LAMBDA core effort. Currently eight Bachelor of Arts programs based on the LAMBDA core have been approved by the faculty and are in place. They are: Anthropology, Computer Science, Economics, History, Philosophy, Political Science, Psychology and Sociology. On the average 33 students are enrolled in LAMBDA courses each semester.

In order to insure the continued success of the LAMBDA effort it will be essential to add two or more Bachelors programs. We are considering adding Bachelors programs in Management Information Systems and possibly in Music and in Artificial Intelligence. Addition of these programs should provide a critical mass of students large enough to maintain the LAMBDA effort. The addition of new Bachelor degree programs is the major activity planned for the immediate future.

Several methods are being used to disseminate the results of the project. The LAMBDA core programs now appear in all of the literature describing the academic programs available at Case Western Reserve University. Also, the LAMBDA programs have been featured in a continuing series of institutional advertisements that the university has developed. Some aspects of the LAMBDA core program have been discussed in one scholarly paper (Prof. Reif) and a more general written paper describing the LAMBDA programs will be prepared shortly by Professor Angus and Professor Rosenberg. Furthermore, we believe it likely that at least one, and perhaps as many as three, textbooks may arise out of the LAMBDA efforts (Biology, Earth Sciences and Physics). These would be science textbooks designed for non-science majors.

Evaluation of the success of the LAMBDA programs is maintained on a continuing basis through the normal channels of the Office of the Dean of Academic Affairs. In brief, there is no concern over the quality of the LAMBDA programs and it is felt they meet a very real academic need. There is, however, considerable concern that the numbers of students taking LAMBDA courses (currently averaging 33 per semester) is not enough to insure continuation of the programs.

2.6 Summary and Conclusions

A radically new Liberal Arts/Mathematics based core curriculum (LAMBDA core) has been implemented. Eight Bachelor of Arts degree programs based on the LAMBDA core are now in place. On the average, 33 students are now taking LAMBDA courses each semester.

To maintain a critical mass of students which will insure the long term viability of the LAMBDA effort it is essential that two or more new Bachelors programs be added.

3.0 DETAILED DISCUSSION OF PROJECT ACTIVITIES

3.1 Introduction

Section 3 of the Final Report includes separate reports by the individual faculty participants in the LAMBDA core activities. These reports are highly individualized and differ significantly in length and style. They give an unusual perspective, not only on the actual accomplishments, which were many, but also how the LAMBDA core activities were perceived by the faculty.

3.2 Mathematics: Professor Charles Wells

The author received a reduction in course load to develop materials for courses required for the LAMBDA core. The main accomplishment was the revision of class notes for the discrete mathematics course, MATH 304. These notes cover every topic taught in the course with the exception of about a week's worth of material on binary trees. The notes include exercises, some with answers, and an index.

These notes are innovative in two ways. The revision consisted in part of introducing these innovations and weaving them in with the rest of the materials, which was completely rearranged compared to earlier versions.

- Mathematical reasoning is taught as an explicit subject (Chapters 2, 8, 10–15). It has become obvious that in the last fifteen years American students are not expected in high school to reason their way through a complicated problem. Some students have a natural ability for this and do not have to be taught. Most students at CWRU have the ability to learn how to reason if they are taught explicitly how to do it.

  The author has found it useful to teach mathematical reasoning using the technique of naming and explaining some of the basic ideas in logic (implication, contrapositive, quantifiers) and explaining some of the basic techniques of proof with examples. This experience is reflected in the chapters named. The logic is introduced informally, not as a formal system as in classes in mathematical logic. Mathematicians have traditionally felt that spending time on this takes away from the "real" subject matter, and they are correct. It is clear, however, that the deficit among our students in reasoning ability is so great that class time must be spent on this topic and these notes reflect that. A typical course in discrete mathematics which does not do that can cover three or four weeks' additional topics compared to one based on these notes.

- The problems involved in reading and writing mathematical prose are discussed throughout the notes in subsections typically called "Warning" or "Fine Points". Another deficit in our students related to the one mentioned previously is their lack of experience in reading closely–argued materials. Part of their difficulty is lack of familiarity with the turns of phrase used in such writing, and variation in terminology (not to mention inappropriate or misleading terminology). An example is the discussion of laws, which explains the mysterious way in which mathematical texts often give a law using a convention that one does not say that it holds for all values of the variable, although in fact it must.

  The author also began the development of some Hypercard programs to be used by students in the course. At this point, the programs are not ready to use, but

they will be made available on the new network being constructed at CWRU and will be tested during the academic year 1990–1991 (the delay is occasioned partly by the author's sabbatical). The point of the programs is to reduce some of the routine computations associated with certain topics in number theory and graph theory so that the student can explore and play with the ideas without getting bogged down in lengthy or difficult calculations. The package will be made available with its Hypertalk source code so that the student so inclined can modify or extend it.

3.3 Mathematics and Statistics: Professor Wojbor A. Woyczynski

My participation in the FIPSE grant activities was restricted to development of a new course on Mathematical Models (MATH 225) which is one of the basic courses within the LAMBDA Core. The work done before the beginning of the Fall Semester 1988 was spent mostly on selecting a large number of real life examples which could be modeled using a relatively modest amount of mathematics (as expected from the LAMBDA Core students). Several models related to study of traffic problems, optimization theory, population dynamics and game theory have been selected and materials were prepared for student's use.

However, when the actual enrollment became known at the beginning of the semester, it turned out that all the students in my class were Computer Science majors, so, several of the above topics turned out to be inappropriate and new topics had to be developed that would take into account a greater sophistication of the class. As a result we implemented the syllabus that concentrated on developing the computer image reconstruction and restoration techniques which were based on ideas borrowed from statistical mechanics. In particular we discussed the annealing and stochastic relaxation methodology in reconstruction of images subject to linear, nonlinear and random distortions. A large number of computer experiments were conducted and the students were required to submit a final project wherein they reconstructed a distorted image of their choice. Some of the students continued their interest in this topic after the class was over and are curren 'y working with me on more advanced projects.

3.4 History: Professor Alan Rocke

During the summer of 1989 I developed a course new to me (though not to the LAMBDA core), Natural Philosophy I. This course had previously been taught exclusively in the Philosophy Department, with the designator PHIL 203, and now has added a cross–listing to HSTY 203. It was necessary to broaden participation for Natural Philosophy into the History Department, since for curricular flexibility, especially during a faculty member's leave semesters, any required course must have more than a single qualified instructor in the College available to teach it. As the course is essentially concerned with the history and philosophy of science, and I am an historian of science much interested in (and competent to teach) the philosophy of science, I am the suitable second instructor. But the course had to be designed and implemented according to my own greatest competencies and interests. In doing so I consulted closely with Professor Colin McLarty, who has been teaching this course in the Philosophy Department.

The overall thrust of the course is an examination of the evolution and modern character of science, and especially its conceptual and methodological elements, by examining the history of selected episodes with an eye to philosophical themes. The three historical philosophers (or philosophical historians) I have chosen as guides to this interesting intellectual landscape are the early nineteenth–century sage John Herschel, author of a still classic Discourse on Natural Philosophy, and two contemporary scholars of high repute as both historians and philosophers, David Hull and Thomas Kuhn.

The major episodes I will cover are the Copernican, the Darwinian, and the Einsteninian (special-relativistic) revolutions. Kuhn and Hull respectively provide the material for the first two, and Banesh Hoffmann's fine biography of Einstein the material for the last. The students will write an in-class midterm examination, a take-home final, and a paper whose goal is to analyze a nineteenth-century critique of Darwin's Origin of Species (many to choose from are reprinted in Hull's book), according to the epistemological and methodological standards of (a) the critic; (b) Darwin himself; and (c) the student's own developing ideas on the subject. Class sessions will include dedicated discussion periods as well as lectures.

3.5 History: Professor Jan Reiff

Travel: Attended International Conference on Computers and the Humanities in Toronto, June, 1989. Coordinated the session sponsored by the American Historical Association on the use of computers in the undergraduate curriculum. Presented a paper on the experience of the history LAMBDA core course (HSTY250).

Supplies: With funds generated by my teaching the statistics course for the Mandel Center on Non-Profit Management, the History Department purchased an AT & T 386 machine that will serve double purpose as the machine for the departmental assistant and as a machine for faculty training and use. We are also purchasing a scanner, OCR software and a laser printer. The supplies funds went to purchase Microsoft Excel for spreadsheeting and graphics, PageMaker for desktop publishing, reference manuals for those two packages and for Microsoft Word, two LaserJet printer cartridges and backup diskettes.

Since my arrival in the department, four faculty members have purchased new computers and others are looking to buy. Next week we are having a departmental meeting (voluntary) to discuss database software and how it can be useful in organizing historical research. Having a powerful department machine with substantial text and graphics capabilities will, I think, get more faculty members intrigued by the possibilities of computers.

Summer Salary: Because the LAMBDA core encourages associated departments to incorporate mathematical analysis into courses beyond the departmental methods course, I spent time this summer developing courses that I could offer in the department that would introduce students to that approach in history. The proposal for the social and cultural history course (HSTY 362) was submitted earlier with the larger LAMBDA proposal. That course will not be offered this year, but I will be teaching HSTY 358, America Since 1940.

For that course, I ordered two datasets from the InterUniversity Consortium for Political and Social Research. The first, the Detroit Area Study for 1953, explores mothers' attitudes toward child raising along with their political, ethnic and class identification. I plan to have students use that data to explore attitudes toward the family, the role of women, the impact of Dr. Spock, the relationship between behavior and political affiliation, and a variety of other 1950s topics.

I have also ordered a 1966 public opinion poll on the war on Vietnam. Clearly the Vietnam War and the growing opposition to it played a crucial role in American history from 1960 on. Analyzing this dataset with SPSSPC should help students to understand how divisive an issue the war was.

I also spent some time this summer exploring the possibilities for creating a computer/statistics based analysis packet to be incorporated into the revised HSTY 112

(Introduction to American History) course that is part of the history department's core sequence. I will be teaching that course this spring and hope to develop such an element for the class. I am hopeful that it might be included, especially if I can secure as a TA one of the graduate students who is taking HSTY 470, the quantitative methods course for our graduate students.

3.6 Psychology: Professor Robert Greene

I received partial summer support in the summer of 1988 from the FIPSE grant to allow me to prepare a new course, PSCL 103 (Introduction to Cognitive Science). The course was intended to be an introduction to the interdisciplinary study of mental processes and therefore required that I familiarize myself with recent developments in artificial intelligence, philosophy, linguistics, the neurosciences, and the history of science so that I could discuss the psychological implications of these developments. Also, I wrote up six computer programs that simulated major psychological phenomena (in an admittedly simplistic way). As one of the requirements of the course, students must work their way through the programs. This experience was intended to both familiarize students with the basic psychological phenomena and also to expose them to the logic of computer simulation in psychology.

PSCL 103 was offered for the first time in the spring of 1989. The course is scheduled to be offered in the spring semester every year.

3.7 Anthropology: Professor L. Greksa

The FIPSE grant was primarily used to enhance the quantitative/computer components of existing quantitative courses. Additional improvements will continue to be made in these courses as the data tapes which were purchased from the grant are integrated into the quantitative courses. However, any further major enhancements of Anthropology courses (i.e., ones justifying additional grant funds) would require the integration of computer technology into traditional lecture courses. This is an option which several of us envisage occurring at some point in time. For example, computer simulations demonstrating the evolutionary consequences of different intensities of natural selection or different rates of gene flow could be used to illustrate the materials covered in our introductory physical anthropology course. However, until the University is hardwired* and micro–computers are either more available to students or are a requirement for entrance to the University (i.e., so that students both have ready access and are adept users of the equipment), the cost (in instruction time) of teaching students how to use the hardware and of ensuring they have access to that hardware seems greater than the benefits.

3.8 Management: Professor Michael Ginzberg

Our objective is to develop a management information systems major for the BS in Management Science program based on the LAMBDA core. This would be a more focused, discipline–based major than is possible in the current BS in Management or BS in Management Science programs. The program would include coverage of the AACSB "Common Body of Knowledge," but in more abbreviated form than is the case in the current programs. This will allow greater concentration in the major area and a reasonable number

*Hardwiring of Case Western Reserve University through an optical fibre network was completed in the fall of 1989. This network connects the dormitories and all academic buildings.

of free electives (the majority of which should be taken outside of the management or economics areas).

So far, we have drafted a proposal for a program which has been circulated among department chairs and the faculty council in the Weatherhead School. The proposal included the suggestion of several new courses in the Management Information Systems area, including a course in Social Implications of Information Technology (hopefully to be developed and taught jointly with College faculty) and a two–term Design Workshop (to be the Senior project). The draft succeeded in arousing the "interest" of the faculty, at least in part due to its radical surgery to the Common Body and its implied expansion of Weatherhead School of Management undergraduate course offerings. Our next step is to work with those interested faculty to define a program which will be acceptable to the school and will be of sufficient depth and rigor to keep the interest of the faculty.

I am chairing the School of Management Undergraduate Committee this year, and development of this (or a similar proposal is our primary charge. Dick Boland will continue to work closely with me in this project.

3.9 Biology: Professor James Zull

A course entitled "Concepts for a Molecular View of Biology" (BIOL 119) was developed as a Biology component of the LAMBDA core. This course represents a new concept in education of beginning college students with an interest in modern biology. It assumes only that the students have been exposed to high school chemistry. Beginning with the elements and the periodic chart, this course heads directly toward a description of the molecules of Biology. The concepts of bonding of atoms, structure of organic molecules, quantitative concepts of the mole, ionization of weak acids, equilibrium and free energy, and kinetics are developed in sequence. At the end, the students have a good understanding of the chemical structure of DNA, the ideas of enzyme catalysis, and the molecular character of living organisms. They then follow this course with a second semester of introduction to Biochemistry (BIOL 120), where they build on these principals and apply them to areas such as protein structure, metabolic pathways, cell membrane structure and function, and the molecular basis for inheritance. BIOL 120 has also been modified to follow naturally from the material presented in BIOL 119.

These two courses represent the Biology component of the LAMBDA core. They stress quantitative aspects of modern molecular biology, but they do not assume prior knowledge in the field. Thus, the courses also serve additional students in other programs. For example, the "Non–traditional" Medical School Applicants, a group of students already accepted into medical school but who have little or no science background, have utilized these courses with remarkable success. The BIOL 119–120 sequence is also being used by freshmen who want to get an early start in the Biochemistry and Biology major at CWRU. In the past, students have waited until they have three semesters of chemistry before taking BIOL 120, but the availability of BIOL 119 does not make it possible for them to enter these programs sooner. A total of 15 students have taken BIOL 119 in the two years it has been offered.

No textbook exists which develops chemistry in the way it is done in BIOL 119. Therefore, the lecture notes have been written out and these represent the beginnings of a potential new textbook. It seems likely that such a book will find a substantial market, since it allows students to obtain a rigorous introduction to the popular field of Molecular Biology in their Freshman year.

The catalog course description for BIOL 119 is given below:

BIOL 119. Concepts for molecular biology. Introduction to the principles of chemistry which are essential to understanding biochemistry and molecular biology. Topics covered include: bonding and structure of organic molecules; molecular quantitation including the concept of the mole, calculations of molar equivalents, concentrations of ions and molecules in cells; effects of charge and polarity on properties of molecules; ionization and pH; and resonance. The course concludes with applications of these concepts to the properties of DNA and RNA, and with a discussion of current theories of how life evolved from the atoms which are believed to have existed on the surface of the primordial earth. This course provides the chemical background required for BIOL 120, and can substitute for the chemistry requirement for that course.

3.10 Earth Sciences: Professor Sam Savin

The course: GEOL 101, The Earth and Planets, was developed under FIPSE support. This course is part of a two course sequence entitled The Evolution of the Earth and Planets. The other course in the sequence, Geologic Cycles, is taught by Professor Matisoff. The sequence has been designed so that either course may be taken first.

The goals of the course are fourfold.

1. To teach the student the scientific method. Throughout the course there is stress on the question of "how we know what we think we know".

2. To teach the students basic concepts of mass and weight, time, order and disorder, conservation of mass/energy, radioactivity and nuclear processes, and symmetry.

3. To teach the students about the nature of the earth and inner planets, stressing the areas of

   a. the earth's internal structure and how we know about it

   b. the evolution of our thinking about the magnitude of geologic time and techniques of measuring time

   c. the cycling of material through the geological system and the sources of energy necessary for the operation of geologic processes

   d. the origin of the solar system and the earth in the context of the inner planets

   e. the nature of minerals, stressing concepts of order and symmetry

   f. other expressions of order in nature, such as ocean waves

4. To do all of the above from a quantitative point of view, stressing two sorts of computational skills

   a. rapid, approximate computation

b. computation done using the computer. This involves teaching the students the elements of computer programming so they can take a scientific problem and write their own program to solve it.

The course is taught in a traditional lecture/discussion format. A collection of required readings has been compiled from chapters in a variety of books and materials written especially for the course by the instructor. Writing these materials is a continuing process, with additional ones being added each time the course is taught. The students are also given a series of specially prepared homework assignments, each of which involves writing and running one or more computer programs. The computer language of instruction is BASIC, but students who are familiar with Pascal are free to do their work in that language. Students may do their computer exercises in the University's undergraduate computer laboratory or elsewhere if they choose.

FIPSE support has been used for all aspects of course development: refinement of the syllabus, development of the computer exercises, development of the reading materials, and preparation of lecture notes.

3.11 Sociology: Professor George Rosenberg

We have now developed the entire one year introductory sequence of courses for LAMBDA core in the Sociology Department (SOCI 112 and 113—both computer based). SOCI 113 was given for the first time in the Spring semester of 1988. It will be offered again in the Spring of 1990—I will be teaching it. I have encouraged another of our department faculty, Professor Eugene Uyeki, to become involved in the computer based courses for LAMBDA students. He is teaching SOCI 112 this semester. We are using a fairly recent data base for this course, 1985 General Social Survey. And next semester, I will use the 1987 General Social Survey in SOCI 113. These materials were purchased with FIPSE money, and as you can see they are enabling us to keep the course timely and relevant.

Our ability to teach LAMBDA core students in Sociology has been enhanced further by the purchase of a number of statistical packages, some of which are "teaching" programs in the sense that pedagogical aids to their use are built into the package.

We have started to use the Smith Computer Lab to teach the introductory sequence of courses. This has made it possible to give the students much larger data files than heretofore. It also increases their flexibility at all stages of learning.

3.12 Sociology: Professor Kyle Kercher

As a result of money from the FIPSE grant, I was able to develop an undergraduate course on designing evaluation studies. The course will emphasize "hands-on" use of the computer. Students will analyze appropriate data sets using SPSSPC statistical ("number-crunching") software.

The course will also include exposure to software that aids students in making decisions about important methodological issues in evaluation studies: type of research design, sampling technique, data collection procedure, measurement and scaling strategies, and choice of appropriate statistical analyses. The FIPSE grant provided the funds to purchase this "artificial intelligence" software I've just described.

I'm also incorporating the software into current methods courses. I expect it to be an excellent pedagogical tool.

The FIPSE grant has also made indirect contributions to the content of my and other professors' courses in our sociology department. As a consequence of the greater emphasis on quantitative approaches among our faculty, students both come into and leave my class with a better understanding and training in quantitative thinking. In other words, we can set higher standards (demand more) because students are better prepared. The process is one of synergy.