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ABSTRACT

In 1998, the Institution-Wide Reform project at the University of Hartford (Connecticut) was evaluated. The main focus of the project was the improvement of teaching and learning in the science, mathematics, engineering, and technology (SMET) disciplines for freshmen. Documentation from various sources indicated that the program accomplished its goals at a reasonably high level. Participating faculty and administrators, who were interviewed by the principal evaluator, gave high marks for the project's design and implementation. Through workshops, seminars, and networking, faculty received professional development focused on the innovative teaching methods, including problem solving, collaboration, multiple intelligences, real world applications, and technology use. The faculty reported significant changes in student enrollment patterns (a preference by students to take courses from faculty members participating in the initiative) and increases in course retention rates. Faculty also reported a generally favorable impression among students in regards to innovative materials and methods. Faculty and administrators indicated that they valued the increased collaboration with colleagues. Recommendations are made to refine the elements necessary for systemic change. (Contains 36 graphs.) (SLD)

CRE
Curriculum Research & Evaluation

Integrating Student-Centered Teaching Methods into the First Year SMET Curriculum: The University of Hartford Model for Institution-Wide Reform

Principal Investigators

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Summative Evaluation

April 1999

TABLE OF CONTENTS

ABSTRACT iv

INTRODUCTION 1

METHODOLOGY 2

THE UNIVERSITY OF HARTFORD 3
1. General Description 3
2. Library Facilities 3
3. Computer Facilities 3
4. Profile of 1997 Freshman Class 3
5. Secondary School Class Rank and Percentage of 1997 Freshman Class 4
6. Test Scores of 1997 Freshman Class 4
   SAT 4
   ACT 5
7. Undergraduate Students' Majors in General Categories 5
8. Student Body Characteristics 6
9. Undergraduate Faculty Statistics 6
10. Summary 7

MAIN PARTICIPANTS 8

ANTICIPATED RESULTS 9
1. Curricular Reform 9
2. Technological Enhancement 9
3. Faculty Development 10
4. Institutional Commitment to Continued Reform 10
5. Supplemental Instruction 10

INSTITUTION-WIDE REFORM INITIATIVE 12
1. Workshops 12
   A. Summer 1996 12
   B. Summer 1997 12
2. Courses 13

DISCUSSION OF FINDINGS 15
1. Qualitative Data 15
   A. Co-Principal Investigators 16
      Getting the Word Out 16
      Dean of Faculty Position 16
      Discussion and Collaboration 17
      Perks and Milestones 17

Mini-Grants 18
Impact on Students and Courses 18
Lessons Learned 21
Next Steps 22
New Grants 22
Closing Remarks 23
B. Faculty 31
Faculty Collaboration 31
Impact on Students 31
Impact on Pedagogy 31
Freshman Level Courses 32
Technology Applications 32
Assessment of Impact 32
Example: The Engineering College 32
1. Teamwork. 32
2. Impact on Engineering Students. 33
3. Cross-Disciplinary Collaboration. 33
4. Overall Impact on the Engineering College. 34
C. Courses 36
Chemistry 36
Mathematics 36
Other SMET Disciplines 36
Ward College 37
1. Introduction to Physics. 37
2. Rationale for Changes. 37
3. Results. 38
4. Related Changes. 38
5. Overall Impact on Ward College. 38
D. Administration 39
Administration's Perspective on Institutional Reform 39
1. Results. 39
2. Outlook for the Future. 40
Faculty's Perspective on Administration and Institutional Reform ... 40
1. Implementation Stage. 40
2. Perceived Shift in Focus. 40
3. Impact on Faculty. 40
4. Problems with Red Ink. 40
5. Outlook for the Future. 41
E. Students 42
Changes in Pedagogy 42
SMET Students' Response 43
Assessing the Impact on Students 43
F. Institution 45
Faculty Work 45

Professional Development 45
Long-Term Issues 46
Overall Impact on the Institution 47
G. Summary 47
2. Quantitative Analysis 49
A. Methodology 49
B. Regression and Analysis 50
Analysis by Ethnic Group 50
1. Whites. 50
2. African Americans. 51
3. All Others. 52
Analysis by Gender 53
1. Males. 53
2. Females. 53
Analysis by Age Category 53
1. Age≤19. 53
2. Age≥20. 54
Grade Analysis 54
Analysis by Ethnic Group 56
1. Whites. 56
2. African Americans. 61
3. All Others. 66
Analysis by Gender 71
1. Males. 71
2. Females. 76
Analysis by Age Category 81
1. Age≤19. 81
2. Age≥20. 86
Summary 91
Final Notes on Quantitative Analysis 92

CONCLUSION 93

RECOMMENDATIONS 95

BIOGRAPHICAL SKETCHES 96

Integrating Student-Centered Teaching Methods into the First Year SMET Curriculum: The University of Hartford Model for Institution-Wide Reform

Summative Evaluation
February 1999

ABSTRACT

In spring 1998, Curriculum Research & Evaluation conducted an external evaluation of Institution-Wide Reform at the University of Hartford, located in Hartford, CT. The reform project's main focus was the improvement of teaching and learning in the science, mathematics, engineering, and technology disciplines for freshmen. It was funded by a two year grant, totaling $179,987, from the National Science Foundation.

The project began in 1996 and ended in 1998. Co-principal investigators were Catherine Stevenson, Dean of Faculty, and Mako Haruta, Associate Professor of Mathematics, both at the University of Hartford. Data collection involved interviews with key participants at the University and analysis of course enrollment data and student opinion surveys.

Documentation from various sources indicates that the project accomplished its objectives at a reasonably high level. Participating faculty and administration, who were interviewed by the principal evaluator, gave high marks for the project's design and its implementation. Through workshops, seminars, and networking, faculty received professional development focused on the use of innovative teaching methods—including collaboration, problem-solving, multiple intelligence, real world applications, and technology use. There was also emphasis on gender-centered methods, culture-centered methods, and institutional change.

The faculty report significant changes in students' enrollment patterns—namely a preference by students to take courses from faculty who are participating in the initiative—and increases in course retention rates. Also, faculty detect a generally favorable impression among students regarding the increased emphasis on innovative methods and materials. Faculty and administration indicate that collaborative work with colleagues has produced a number of important benefits. It has been especially valued for bringing people together, for the first time, who work in the same buildings or in other buildings located elsewhere on the campus. Also, study participants appreciate the increase in proposed and funded external grants that are related to this initiative, the change in University policy that recognizes and rewards contributions to institution-wide reform; and the establishment of a campus center for professional development.

Although the initiative realized significant progress with various reform-oriented goals during its two-year development, a number of institutional issues continue. Approximately 25 percent

of the faculty that CRE interviewed are concerned that administration has shifted decision-making from an open and collaborative style to a more exclusive approach. Also, most participants report that insufficient work has been done, thus far, to assess the impact on targeted audiences, especially students.

Recommendations for the initiative's next phase of development focus on refinements to the elements necessary for systemic change. Those include use of process improvement strategies, professional development for teamwork, accountability for results, and positive workplace attitudes.

Integrating Student-Centered Teaching Methods into the First Year SMET Curriculum: The University of Hartford Model for Institution-Wide Reform

Summative Evaluation
February 1999

INTRODUCTION

In March 1998, the University of Hartford (U of H), located in Hartford, Connecticut, retained Curriculum Research & Evaluation (CRE) as an independent, external evaluator to conduct a summative evaluation of Integrating Student-Centered Teaching Methods into the First Year SMET Curriculum: The University of Hartford Model for Institution-Wide Reform. The National Science Foundation awarded a grant of $179,987 to the University of Hartford for support of the Institution-Wide Reform project, effective from July 1, 1996 through June 30, 1998.

The overall goal of Institution-Wide Reform is to strengthen the University's cross-collegiate framework of the science, mathematics, engineering, and technology (SMET) disciplines in order to

- foster faculty collaboration and development;
- increase curricular coordination; and
- emphasize innovative, student-centered pedagogy.

Ultimately, this University of Hartford initiative is to develop a national model for institution-wide reform of introductory-level undergraduate education in SMET.

Institution-Wide Reform addresses the general problem of low student performance in higher education—particularly in the SMET disciplines—by extending the University's previous efforts in improving the teaching of humanities disciplines. These preliminary efforts have given the institution a platform from which to scale up for more broadly-based consensus-building and change. The key elements of Institution-Wide Reform are to

- continue the shift from teacher-centered to student-centered, inquiry-oriented, and gender- and culture-centered instructional methods;
- engage in a realistic process of institutional change;
- create a new spirit of institutional cohesion;
- establish collaboration as a key element of the teaching-learning process; and
- promote discussions among faculty and administration on strategies in order to improve the undergraduate program in SMET disciplines.

In order to facilitate implementing the project, the University of Hartford organized a select team of faculty and gave it a leadership structure that maintains a balance between intellectual/curricular issues and administrative skills. The group's purpose is to develop a plan for redefining resource-allocation mechanisms to support and to institutionalize the reform agenda.

Briefly, Institution-Wide Reform is viewed as a successful initiative by the study participants. CRE agrees with this assessment. Substantive changes have been introduced in courses, programs, policy, and campus culture. There were no significant obstacles to the initiative's two-year development. The Dean of Faculty as a co-principal investigator was included along with a faculty member in order to assure that the concerns of both administration and faculty would be addressed.

Despite the initiative's overall success, a number of issues remain. This result is not surprising, since the grant has had only two years of development. A major issue is faculty concern that administration is shifting away from collaborative work and shared decision-making, particularly in reference to determining the nature and the pace of systemic change. Administration exercises caution, with respect to committee appointments, in order to select individuals for membership. Additionally, there is a need to document more systematically and rigorously the initiative's impact on students, programs, and campus culture.

CRE provides a conclusion and recommendations for further development. The report is written in a style that provides readers with an opportunity to review a substantial amount of documentation and to draw their own conclusions. CRE hopes that the report is useful to the University of Hartford in its continuing efforts toward institutional reform in SMET.

METHODOLOGY

CRE conducted this evaluation study from March 1998 through January 1999. The evaluation design employed both quantitative and qualitative methods for data collection and analysis. Quantitative methods involved study of institutional records, including statistical analysis of data from internal evaluation studies, enrollment statistics, and surveys. Qualitative methods consisted of site visits and formal interviews with key participants at the University of Hartford. Those participants included co-principal investigators, department chairs, deans, provost, staff, and faculty. Additionally, CRE collected course syllabi, reports, meeting minutes, program descriptions, policy statements, and papers written by participating faculty.

THE UNIVERSITY OF HARTFORD

The following information describing the University of Hartford is available from its Internet web site located at http://www.hartford.edu.

1. General Description

- Founded in 1877
- Private, comprehensive liberal arts institution
- Coeducational
- Four year and graduate degrees
- Semester system, with two summer sessions of five to six weeks each
- Accredited by the New England Association of Schools and Colleges (NEASE)
- Programs are offered through Colleges of Arts and Sciences; Basic Studies; Education, Nursing, and Health Professions; and Engineering
- Additional programs are offered through Barney School of Business and Public Administration, Hartford Art School, Hartt School of Music, and S.I. Ward College of Technology.
- 300-acre campus is located in West Hartford, two miles from downtown Hartford.

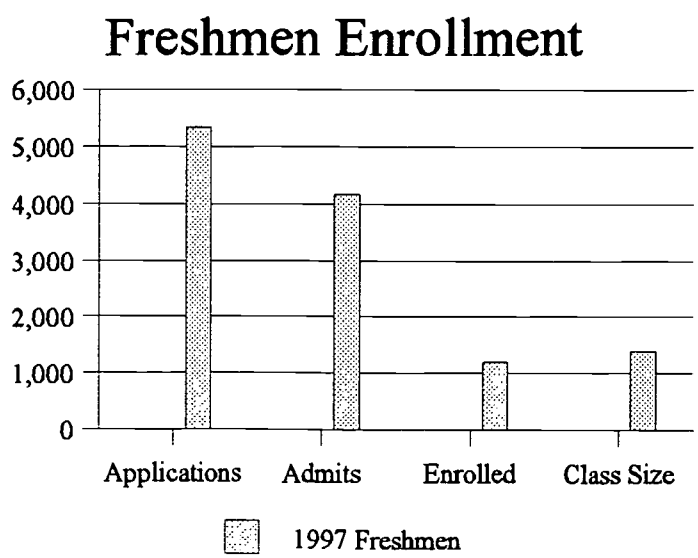
2. Library Facilities

- Number of books, serial backfiles, and government documents: 437,886
- Number of current serials (titles): 2,088
- Number of microform titles: 243,891
- Additional library facilities/collections: Access to libraries of consortium schools

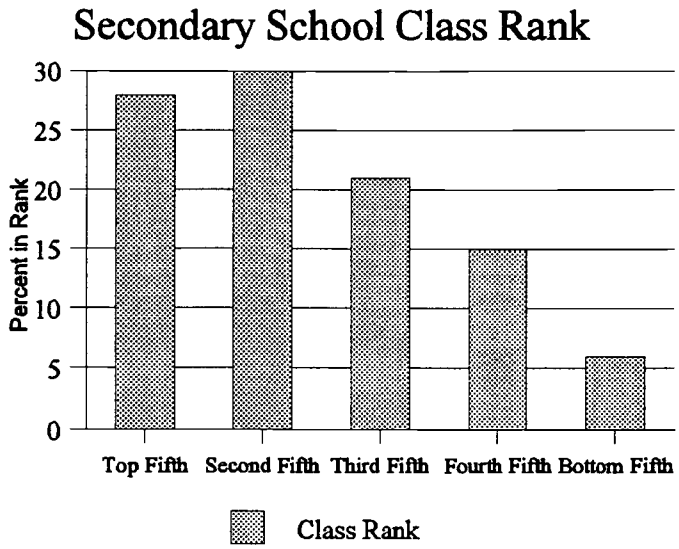
3. Computer Facilities

- Every student is required to take a computer course
- Total number of microcomputers available to students: 300
- Computer equipment is provided in residence halls
- School provides e-mail services/accounts for students.

4. Profile of 1997 Freshman Class



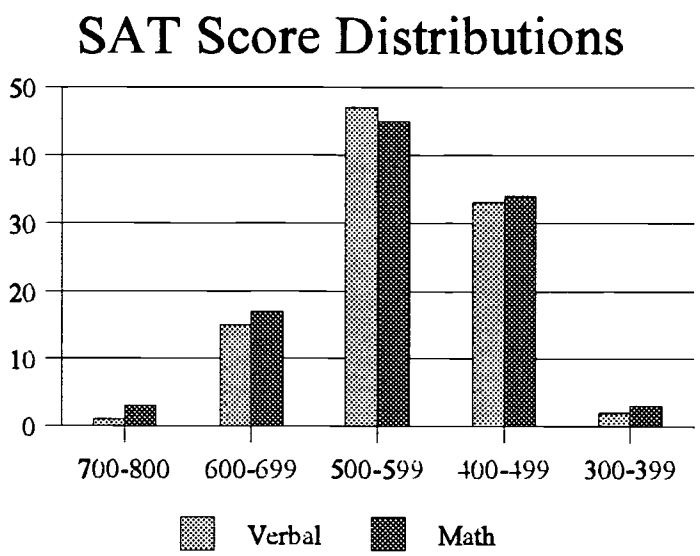
5. Secondary School Class Rank and Percentage of 1997 Freshman Class



- Percentage of freshmen who submitted class rank: 72%
- Percentage of freshmen that came from public schools: 79
- Number of secondary schools represented in the class 894
- Percentage of freshmen that came from out-of-state: 76

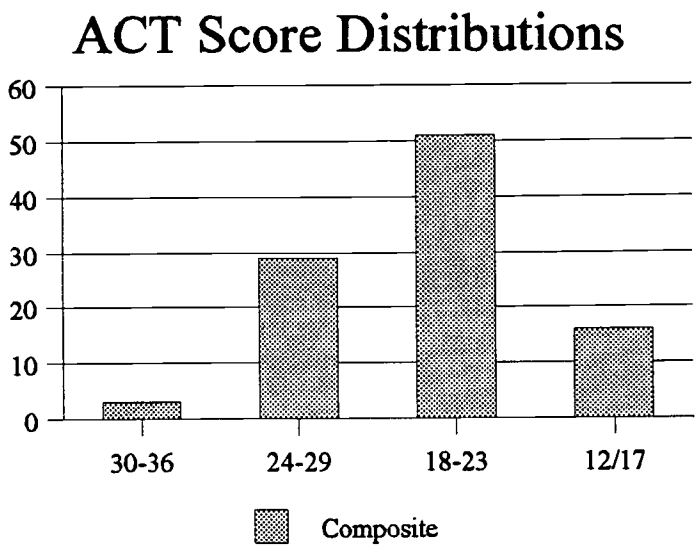
6. Test Scores of 1997 Freshman Class

SAT



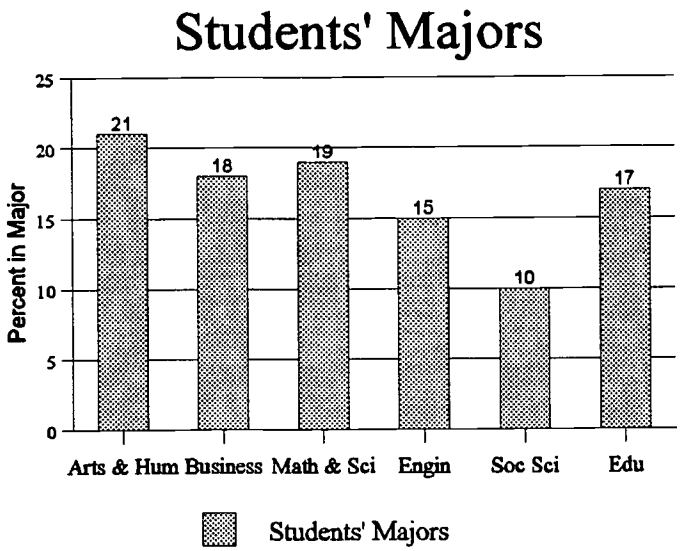
- Percentage of students who submitted SAT scores: 96%
- Average scores: Verbal 527; Math 525; Combined 1,052

ACT



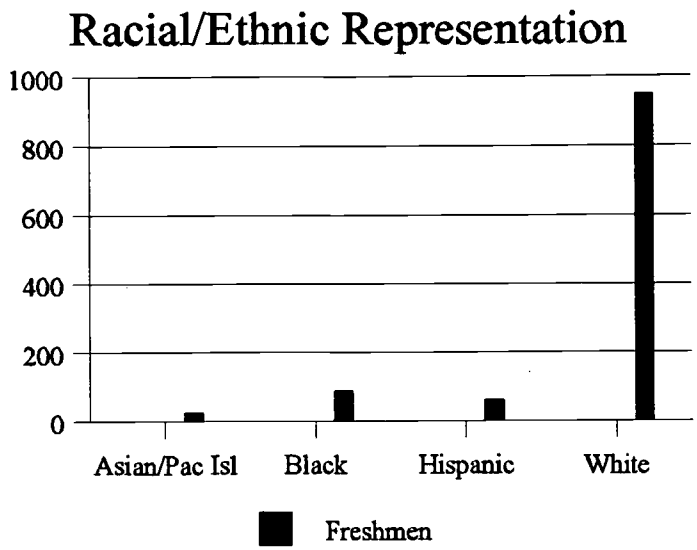
- Percentage of students who submitted SAT scores: 8%

7. Undergraduate Students' Majors in General Categories



- Three most popular majors: communication, mechanical engineering, and marketing
- Least popular majors: women's studies, foreign languages/literatures, and philosophy

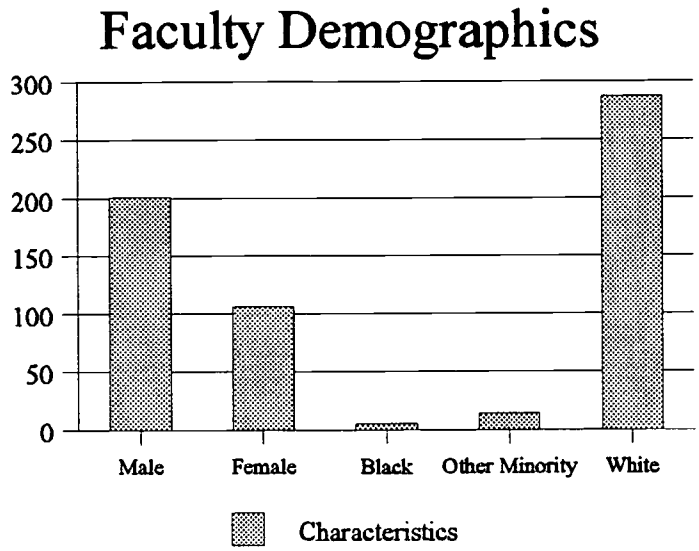
8. Student Body Characteristics



- Based on total population of 1,121 students reporting demographics.

Additionally, the current total full time undergraduate student population is 4,117. The total number of full time female undergraduates is 2,049, which is approximately equal to the total number of full time male undergraduates—2,068. Also, the total number of part-time female undergraduates—736—is 38% larger than the total number of part-time male undergraduates—534. The total undergraduate student population at University of Hartford is 5,387.

9. Undergraduate Faculty Statistics



- Chart indicates total number in 1997-98 in each category.

10. Summary

Analysis of data from two other private institutions of higher education in the greater Hartford area indicates that the University of Hartford is similar to both of these places in many respects, including general faculty characteristics. However, the student population at U of H is much larger than both comparison institutions. Additionally, U of H freshman student performance (as measured by SAT and ACT) is roughly equal to one institution and somewhat lower than the other. During interviews, U of H faculty and administrators said that the students' performance covers the full range, from high to low. Also, they noted that the University has Hillyer College of Basic Studies, that is a two year program for under-prepared students.

There is a substantial number of undergraduate students who select SMET disciplines for their major. Thus, the project is well-placed.

MAIN PARTICIPANTS

Institution-Wide Reform has two principal investigators.

- Mako Haruta is the co-principal investigator for curriculum. Dr. Haruta is Associate Professor of Mathematics at U of H in the College of Arts and Sciences.
- Catherine Stevenson is the co-principal investigator for administration. Dr. Stevenson is Dean of Faculty.

The Reform Team consists of the co-principal investigators and the following faculty members.

- Hisham Alnajjar, Assistant Professor and Chair of Engineering—Electrical and Computer
- Chris Armen, Assistant Professor, College of Arts and Sciences
- Donald Buckley, Assistant Professor of Biology, College of Arts and Sciences
- Howard Canistraro, Assistant Professor of Mechanical Engineering Technology, Ward College of Technology
- Robert Decker, Associate Professor, College of Arts and Sciences
- Eric Danielson, Associate Professor of Science, Hartford College for Women
- James Greenwood, Lecturer, Hillyer College
- Richard Roth, Associate Dean of Students and Associate Professor of Biology, Hillyer College
- Leo Smith, Associate Professor of Mechanical Engineering
- Lee Townsend, Assistant Professor, Ward College
- Mark Turpin, Assistant Professor of Mathematics, College of Arts and Sciences
- Harry Workman, Professor of Chemistry, College of Arts and Sciences
- J. P. Froehlich, Electrical Engineering, College of Engineering
- Alan Hadad, Dean, Ward College of Technology
- Robert Radin, Mathematics and Technology Communications, Ward College of Technology.

Additionally, during the two years of the initiative, there was a staff, which included two secretaries, a Grants and Contracts Director, and an Institutional Research Director. Also, there were nine Supplemental Instruction leaders and five student assistants for editing texts, authoring web pages, and providing technical assistance.

ANTICIPATED RESULTS

Developing a national model of excellence in SMET education is the overall, external goal of Institution-Wide Reform. Additionally, the main participants expect that success with the project will contribute to the knowledge base in systemic educational reform, particularly when applied to relatively small, comprehensive universities.

The main participants also expect that Institution-Wide Reform will produce more specific internal results in the following four areas: curricular reform, technological enhancement, faculty development, and institutional commitment to continued reform—including supplemental instruction.

1. Curricular Reform

Concrete Results of Curricular Reform

A. More cohesive, integrated, and consistent freshman year experience in SMET disciplines
B. Core of introductory SMET courses accessible to larger and more diverse student population
C. Greater student success in introductory SMET courses and increased persistence on to more advanced levels of SMET study
D. More widespread use of collaborative and cooperative learning pedagogies in introductory SMET courses, increased student proficiency in functioning as members of a team, and innovative student mentoring programs, such as Supplemental Instruction
E. More consistent student learning experiences throughout all sections of a particular introductory SMET course

2. Technological Enhancement

Concrete Results of Technological Enhancement

A. More extensive use of instructional technology throughout introductory SMET courses, coupled with individualized support services to ensure receptivity to the technology
B. Better integration of math and science courses and curricula, accomplished in part through greater and more widespread use of instructional technology
C. More extensive use of newest software, enabling students to focus energies on data analysis and modeling problems, as opposed to rote and time-consuming calculations

3. Faculty Development

Concrete Results in Faculty Development

A. Faculty journal publications, development of instructional materials, and conference presentations on innovations in teaching in SMET courses
B. Increased SMET faculty competence in utilizing and modeling cooperative and collaborative learning techniques
C. Increased SMET faculty competence in assessing student learning outcomes associated with collaborative and cooperative learning techniques
D. More effective interdepartmental and intercollegiate communication and collaboration among faculty in SMET disciplines
E. Commitment among SMET faculty to adopting and pioneering innovations in student-centered pedagogies
F. Greater faculty commitment and competency in collaborating to better integrate SMET courses and curricula

4. Institutional Commitment to Continued Reform

Concrete Results in Institutional Commitment to Continued Reform

A. Establish Permanent Taskforce on Innovation in Undergraduate SMET
B. Articulate long-term reform strategy and short-term agenda
C. Evaluate existing reward structures and identify necessary structural revisions designed to support continued reform

5. Supplemental Instruction

Supplemental Instruction was developed by Deanna C. Martin, Ph.D. at the University of Missouri at Kansas City in 1973. SI targets traditionally difficult academic courses—i.e., those where students have a high percentage rate of D or F grades and withdrawals—and offers review sessions to all enrolled students. Those sessions are regularly scheduled, out-of-class, and peer facilitated. SI study sessions are informal seminars where students compare notes, discuss readings, develop organizational tools, and predict test items. Students learn how to integrate course content and reasoning skill. The SI sessions are directed by "SI Leaders", who are usually students who have previously and successfully taken the "high-risk" course and then sit through the course again. The SI Leader acts as a model student of the discipline. SI is offered only in courses in which the faculty member supports the program.

An SI Leader

- receives training in content-specific learning techniques;
- attends all classes, takes notes, and takes all tests or quizzes;
- has no role in grading;
- is supervised by a faculty member who has received training.

SI Sessions

- are voluntary and do not figure into course grade;
- begin the first or second week of classes—supplemental meetings are *not* portrayed as remedial;
- meet three times per week; times chosen are based on student schedules;
- are study skills oriented;
- feature interactive learning strategies.

Results are evaluated via

- attendance records;
- student grades;
- questionnaires

The Supplemental Instruction program at the University of Hartford has expanded from two sections representing one course in Fall 1995 to seven sections representing six courses in Mathematics, Physics, Biology, and Chemistry. The number of SI student leaders has increased from two to six each semester, thereby involving more upper level students in what is a very positive experience. Time in the classroom has been especially valuable for Education majors, who have served as SI leaders

The results of some analysis done on the data taken from these courses has been positive. The current challenge is how to manage the fluctuating attendance rate of students. Students who regularly attend SI are very positive in their responses. They also perform well in the course. Motivational techniques are now being applied to increase the level of participation of the class.

Currently some courses are experimenting with modifications to the program using strategies that include such possibilities as requiring attendance at some minimum number of study sessions; attaching one leader to more than one section; and/or transferring part of the duties of a leader to time on e-mail correspondence with students and the fostering of group study via e-mail. The Biology sessions have a high rate of attendance, due in part to the motivational opportunity to retake tests if a student's study session attendance meets minimum requirements. Introductory Mathematics courses, such as Precalculus (now Modeling with Elementary Functions) and Short Calculus, are able to maintain high attendance when incentives are offered.

The resulting modified program is distinct from the original SI program and its specifications. It is a program unique to the University of Hartford.

INSTITUTION-WIDE REFORM INITIATIVE

The project established a cross-disciplinary team of faculty to implement the institution-wide reform process that focused on introductory SMET courses. The team's work began during summer 1996 at the project's first summer workshop. Participants included national experts on reform and institutional change.

1. Workshops

A. Summer 1996

The three purposes for the first-year summer workshop were

1. to infuse student-centered pedagogies into the instructional process, with a special emphasis on female students;
2. to strengthen student learning with the use of new instructional technology and group problem-solving;
3. to use small work groups to relieve students' fears about SMET courses and to facilitate learning in these fields.

During the summer and subsequent academic year, participating faculty redesigned some courses, implemented new courses, and discussed results with the cross-disciplinary team and other faculty. Additionally, the team met regularly to determine if the project's first-year objectives were accomplished. Key elements in the plan focus on active participation of faculty, on collaboration among faculty, and on accountability for results on individual and group levels—i.e., various academic departments as well as the team and related alliances.

B. Summer 1997

The five purposes for the second-year summer workshop are as follows were

1. to examine lessons learned in the first year;
2. to continue consulting with national experts on institutional change;
3. to discuss next steps;
4. to refine the first-year SMET curriculum initiatives;
5. to identify additional introductory SMET courses for revision.

During the second year of Institution-Wide Reform, the scope of activity employed strategies to broaden and to deepen the systemic change process. The original cross-disciplinary team had two objectives: (1) to serve as mentors of the second-year team and (2) to develop a long-term plan for reform of SMET courses and curricula. To accomplish the second objective, the original team evaluated the University of Hartford resource allocation systems and formulas. The end result is financial support to continue the initiative and to institutionalize the changes regarding introductory SMET courses and curricula.

2. Courses

During 1997 and 1998, the project focused on reform of the following courses across different colleges and departments to improve students' introduction to SMET disciplines.

YEAR 1	
College	***Departments & Reformed Courses***
College of Arts and Sciences	Math 110, Precalculus Mathematics Math 112, A Short Course in Calculus
	Biology 122, Biological Science Biology 123, Biological Science
	Chemistry 110, College Chemistry Chemistry 111, College Chemistry
College of Engineering	Engineering Science 141, Principles of Engineering Engineering Science 142, Principles of Design
Ward College of Technology	Engineering Technology 111, Introduction to Engineering Technology
Hartford College for Women	MAH 115, Introduction to MSET

YEAR 2	
College	**Departments & Reformed Courses**
College of Arts and Sciences	Math 144/145, Calculus I & II
	Physics 120/121 (grant faculty from Ward College)
	CS114, Computer Programming I
College of Engineering	CBL Based Lab Projects
Hartford College for Women	PHH 100, Introduction to Physics
Hillyer College	CSB 190, Mathematics
	SCB 190, Concepts of Science

A summary of changes implemented within each SMET discipline follows.[1]

Biology

- small group work
- student-centered
- intensive laboratory units emphasizing process of science, including BioQUEST
- team-teaching

Chemistry

- students visualize non-observable entities
- expanded use of graphing calculators
- coordination with other courses and disciplines, including mathematics and biology
- utilize interactive instructional technology

Mathematics

- group work
- use of technology, including graphing calculator
- problem-solving by Harvard Calculus approach
- interdisciplinary approach, including chemistry, physics, and business applications
- Supplemental Instruction

Engineering

- fundamental principles and applications to develop students' working knowledge of engineering
- skill development for communication of technical information
- team work and problem-solving to promote retention and skill development
- use of technology for applications in mathematics, physics, & statistics

Engineering Technology

- skills, attitudes, and techniques of professional engineer
- hands-on, multi-media approach
- open-ended research project
- use of technology for applications in mathematics, physics, & statistics

Hartford College for Women

- specially designed, women-only sections of physics, calculus, chemistry, and computer science
- student-centered, technology-based pedagogy
- metacognitive training
- computer applications

[1]Specific contents of course revisions appear in mini-grant proposals, course syllabi, and faculty reports. These documents are available for review from the co-principal investigators, and are on the web site.

DISCUSSION OF FINDINGS

In this section, there is a discussion of data that CRE collected during formal interviews with key individuals who hold positions as faculty and as administrators at the University of Hartford and of data from existing records. Thus, the two general categories for analysis are qualitative data and student records, that is, quantitative data.

In this first section, CRE provides analysis of data pertaining to what study participants said about Institution-Wide Reform. CRE uses the following six subcategories:

A. Co-Principal Investigators

B. Faculty

C. Courses

D. Administration

E. Students

F. Institution

At the end, there is a summary.

1. Qualitative Data

The analysis of qualitative data is a reconstruction of material that CRE collected during interviews with study participants of questions that CRE asked about the development of and the impact of Institution-Wide Reform. The participants included co-principal investigators, professors, staff, and administrators. Approximately 25 percent of the available qualitative data is used in this analysis. Most of the following text is verbatim transcription that has been collated, reorganized, and lightly edited for coherence. The material used in a particular subsection is drawn from different sources at the University, who share a common understanding about some aspect of this initiative. To assure anonymity of sources—except for co-principal investigators—there is no emphasis on and there is no identification of individual study participants.

In most instances, study participants express a highly favorable opinion regarding this initiative. CRE also examines constructive criticism, which largely concerns faculty perceptions of university administration. There was no negative opinion expressed by study participants.

The following are the two main questions that were used for this analysis.

- What has been the impact of Institution-Wide Reform on faculty, courses, administration, and students?
- What has this project contributed to systemic reform of higher education, in general, and the University of Hartford, in particular?

A. Co-Principal Investigators

In this section, CRE presents the co-principal investigators' perspective on Institution-Wide Reform at the University of Hartford. The overall interest in this section is to obtain a history of the initiative—including highlights of its accomplishments—from the viewpoint of its main architects, namely Catherine Stevenson and Mako Haruta, the co-principal investigators.

According to Dean Stevenson and Professor Haruta:

> Before this grant got started, there was no support at the University for institution-wide reform of SMET. As co-principal investigators, we administered the grant; wrote progress reports; presented with other faculty at meetings, workshops, roundtables, and seminars; and collected and disseminated supportive documentation. We organized a number of cross-disciplinary meetings which helped people from different areas of the campus to become better acquainted with each other and to develop a sense of ownership in the project. We also completed our normal responsibilities in teaching and administration.

Getting the Word Out

> Institution-Wide Reform served as a lever to raise awareness across the University to provide high quality education to first year students, especially in SMET. Frankly, we were able to bring faculty out of the woodwork. There were false stories in the institution about support and about risk taking. In the main, these were myths. In general, people would not do things because there was, in their memory, no release time available for this kind of work. More specifically, people changed courses but in an individual and less coordinated fashion.
>
> Through advertisements and announcements of various kinds, we got the word out regarding the opportunities available with Institution-Wide Reform. Suddenly, there were people, who had never done a grant before, signing on for a mini-grant.
>
> Our message to the faculty was, "we value you and we want to help you." The University of Hartford is not a "Research I" institution. Nevertheless, faculty feel the pressure to conduct research and to publish scholarly articles, but they don't always have sufficient release time from teaching and service responsibilities. Thus, it is sometimes difficult to reinforce the behavior and values that we want for the institution. However, we succeeded in reaching the pockets of innovation that are out there.

Dean of Faculty Position

> An important step in the process was establishing a new University position, the Dean of Faculty, and appointing Catherine Stevenson as the Dean. The model established by this grant provides money and other resources for strategic development of faculty and instructional programs. The Dean of Faculty has the responsibility to look around campus for ways to support

teaching, research and publications, and service. Also, a new center, known as the Faculty Center for Learning Development, has been created to institutionalize university-wide work on teaching.

Discussion and Collaboration

Institution-Wide Reform enabled us to create a public forum for discussion of these issues. This work is consistent with the University's strategic plan, especially regarding first-year students and technology use. Institution-Wide Reform focused our attention on intellectual discourse and interaction, or networking. Concerning intellectual discourse, the grant enabled faculty and administrators across campus to engage in serious discussions about their pedagogy. As a result, we raised their consciousness about issues related to classroom instruction and students' learning.

Concerning interaction or networking, we brought together people in this institution who had never before worked together. Once again, the focus was on pedagogy, but these networks were used by faculty to discuss and to share ideas about teaching. Normally, professors don't talk formally about their teaching practice—i.e., their methods and curriculum.

This project started with collaboration. During the first summer in 1996, we convened the faculty to write annual goals for years one and two, concerning faculty development, institutional strategies, and student support.

The collaborative work fostered by Institution-Wide Reform is significant for the University of Hartford because we are a 41 year old institution of higher education with nine different or separate units. In our history, three of these were original and came together as strong, individual units—Hartford Art School, Hartt School of Music, and Hillyer College of Arts and Sciences. The other six colleges developed later. Thus, we are like a federation of colleges, but we need to function as a university.

Currently, an important issue in higher education is how to foster collegiality across the different colleges. This concern is very important to the University of Hartford.

Perks and Milestones

There have been perks and milestones associated with this grant. The perks include release time for faculty to revise courses and programs. We accepted proposals from people who demonstrated that they could work in a collaborative fashion. Also, no one got paid money for work on this initiative—they got perks. Institution-Wide Reform at the University of Hartford is about human energies devoted to specific initiatives.

This grant has helped the faculty and administration to focus on common issues across the University campus. This is an important milestone for us. The main concerns are

- to motivate students;

- to develop innovative pedagogy;
- to improve students' learning.

Everyone here is concerned about the above areas. During the first and second years of the grant, we held workshops on planning and organization in order to address these issues.

When people first came together at the workshops, they didn't know each other, even though some of them worked in the same buildings. There was no sense of "we" on this campus. There were pockets of groups, but there was no generalized concept of belonging, certainly not in SMET. Thus, the workshops helped to create an awareness of the fact that this grant was different and that it was valuable to all. Faculty and administrators, who became involved, understood that this is worth pursuing for the sake of involvement with others and for the purpose of improving the first year programs in SMET.

Changes in the University's policy is another important milestone. The faculty was concerned about the grant's impact on the University's reward structure. Institution-Wide Reform has had a positive impact on promotion and tenure of members. Since implementing this grant, we changed faculty policy on promotion and tenure to recognize the contributions of faculty to grants, in general, and to the improvement of courses and to technology use, in particular.

Also, as co-principals we drew on our past experience and our strengths in the disciplines of mathematics and the humanities in order to focus the attention of faculty on common pedagogical issues—that is, the concerns about high quality teaching that cut across the disciplines.

Another milestone is that we created the Outstanding Teaching Award. This award recognizes up to five faculty members for specific innovations or for extraordinary devotion to students.

Mini-Grants

This initiative distributed requests for proposals for mini-grants designed to improve teaching and learning. Furthermore, the proposals would emphasize use of technology, collaborative learning, and peer support, and they would focus on under-represented student populations. Funding was available for one course release each for a total of up to six faculty. Recipients were required to submit summaries at the end of each proposal period. The grant's sequence of work is to plan, to do, to report, and to reward.

Impact on Students and Courses

This grant has had an impact on the students' experiences in SMET courses. They receive a combination of lectures and hands-on projects in all of the courses that were reformed by this grant. We found that the students were not accustomed to writing assignments in their mathematics classes. They also

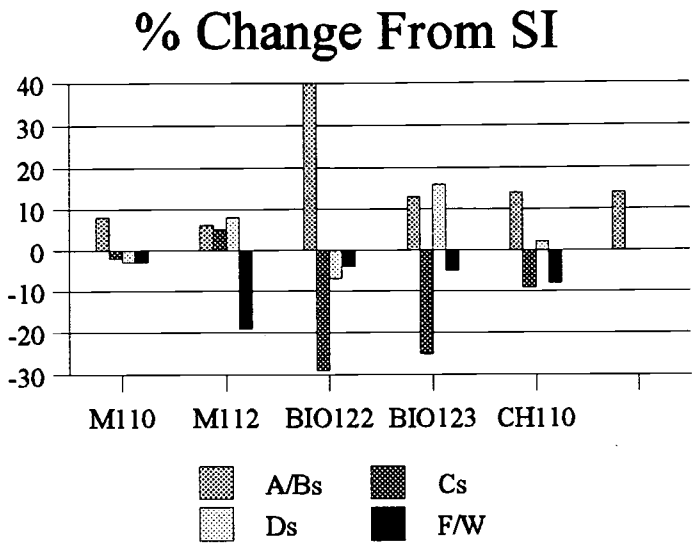
experienced a significant change in the quality of experiments and practical applications that are now offered in the science and engineering courses.

We realized considerable success in the reformed SMET courses. Active learning is replacing the chalk and talk method. There is peer counseling for students. Anecdotal information indicates that the students are achieving positive results. For example, in the past, after the weakest students took the required physics course two or three times, they would still fail. Now, that same type of student will pass the course because there is an organized program—Supplemental Instruction—that provides tutorial assistance from qualified students who have already taken the course. These tutorial sessions emphasize interaction with the content. Answers are not simply supplied, but the students are engaged in a process of problem solving. There is also a focus on study skills. There is constant involvement with other students who are successful. Credit is given for this work. We hope this approach transfers to other contexts across campus.

We introduced Supplemental Instruction into eight introductory mathematics and science courses.

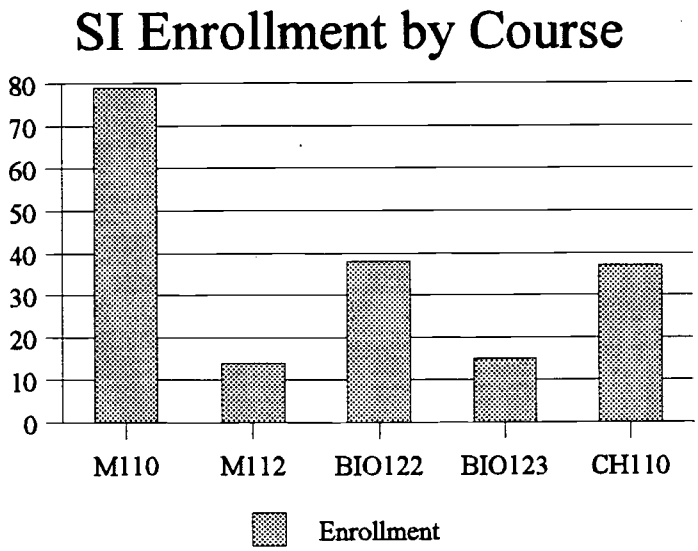
- M110 Modeling with Elementary Functions (formerly Precalculus)
- M112 A Short course in Calculus
- CH110 College Chemistry
- CH111 College Chemistry
- BIO110 General Biology
- BIO111 General Biology
- PHY101 Physics—Mechanics, Heat, and the Body
- PHY112 Calculus Based Physics I

During the grant, the Supplemental Instruction Leaders group was made up of a total of nine students involved in these courses. Four of the students were education/math majors. Each year of the grant, Supplemental Instruction was utilized in a total of approximately twelve sections representing the courses listed above.



The above chart represents the percent change in students' grades from participation in Supplemental Instruction. For instance, the record for BIO122 indicates there was a significant shift in Cs, Ds, and F/Ws as a result of Supplemental Instruction. Results are similar, although less dramatic, for the other courses.

The next chart shows the record of students' enrollment in the Supplemental Instruction program by course. Total number of students served was 183. There were seven sections of M110, one of M112, two of BIO122, one of BIO123, and three of CH110. Students course attendance rates varied between fall 1995 and spring 1998 from a high of 100 percent for BIO122 in fall 1997 to a low of 15 percent for M110 in fall 1997.



Across the campus, we have tried, with the workshops, seminars, and roundtables, to move all departments toward more project-oriented teaching. We are pleased to report that we have realized some success. However, we are going to be honest in saying that the results after two years are mixed. There is some fragmentation the farther away one gets from the faculty and administrators who are directly involved and committed to this project.

There are some obvious linkages between SMET and the arts, notably with music. However, there is no support from NSF for making these bridges. People who work in the arts were interested to see the excitement among SMET faculty, but they felt left out. They asked why they couldn't get support for the same thing. Support for only SMET is a condition from NSF, so there was nothing that we could do about this concern for full scale interdisciplinary reform. However, we tried to make bridges to the humanities. We would encourage NSF to include the arts in its future plans regarding institution-wide reform.

Lessons Learned

The following are important lessons that we learned from Institution-Wide reform.

- Start with what works and build bridges to success.
- Pull together a very capable people—i.e., individuals who are already working on these ideas—and capitalize upon their strengths.
- Secure support from a variety of people, including senior and junior faculty and administration.
- start where the faculty's heart is—i.e., wanting to correct a perceived problem with curriculum and instruction.
- Connect people, get teamwork on your side, build capacity, and build energy to solve the problems.

We made sure that we got the word out as often as possible and in different venues. We continuously went back to the basic concerns of this initiative and asked ourselves: What do we want? By doing this we:

- identified the problems—the obstacles to success;
- did not confine ourselves to a restricted package;
- searched for what people wanted;
- listened to what people said about this initiative, including the gripes;
- kept records;
- did the work; and
- got the job done.

Next Steps

We accomplished our objectives regarding the first year SMET curriculum. The results are available in the reports filed by faculty and in their reformed course syllabi—all are posted on the grant's web page. Now, we have to commence work on the students' second and third years. In our opinion, the fourth year of SMET courses is in fine shape.

Additionally, the next stage in development has to address the transfer of these developments and results to other courses. The mathematics department is already at an advanced stage. This is not so in other areas. Thus, we need to scale up the work on institution-wide reform, with particular attention to implications for the SMET curriculum and instruction.

New Grants

The University has succeeded in obtaining a number of institution-wide grants. The following chart lists the proposed and awarded grants, as of March 12, 1999.

Grant Proposals Directly Related to Institution-Wide Reform of SMET				
Type	**Description**	**Agency**	**Submitted**	**Awarded**
Curric. Dev.	A&S + Educ for SMET	NSF CETP	$1,727,937	
Curric. Dev.	U. partners for chem.	NSF	220,425	
Lab Equip	A&S chemistry	NSF CCLI	26,550	
Lab Equip.	Hillyer science	NSF CCLI	49,853	
Lab Equip.	Hillyer science	NSF-ILI	55,011	
Lab Equip.	Hillyer science	NSF-ILI	69,933	
Outreach	Jr. League/Girl Scouts	JLH	31,467	$ 27,050
Research	Faculty Research	Whitaker Foundation	208,496	
Lab Equip	Ward Coll of Tech	NSF-ILI	15,900	15,900
Lab Equip.	Ward Coll of Tech	NSF-ILI	17,450	
Lab Equip.	Ward Coll of Tech	NSF	12,817	
Lab Equip.	Coll of Engineering	NSF-ILI	11,082	11,082
Curric. Dev.	Engineering	NASA	5,000	5,000
Curric. Dev.	1st yr curric	FIPSE	334,482	274,810
Curric. Dev.	Integrate SMET/A&S	NSF	1,415,058	600,000
	Total		**$4,201,461**	**$933,842**

The new grants listed above will extend our work to new areas.

Closing Remarks

During the past two years, Institution-Wide Reform emphasized reform of curriculum, of student learning, of faculty culture, and of the larger institutional structure. This is one of the few grants that has succeeded in bringing people together on this campus. It gave us the reason to make much needed changes and the means to do so. We have had real conversations around these subjects, not just shop talk. Additionally, there are real results, particularly, in the form of the new grants.

We defined a process to bring together faculty from across campus to create pedagogical reform. Institution-Wide Reform was to spearhead that reform effort. We established the process and brought legitimacy to the grant. There, people wanted to participate—i.e., to be willing to get involved in the work without any guarantees of reward. Now, the University has an institutional thrust in this direction. Having the Dean of Faculty directly responsible for the Institution-Wide Reform initiative facilitated the reform process at the administrative level.

There is also a lot of new activity by individual faculty, who are writing proposals. We have created a new university structure to encourage the preparation of grants. Our grants officer collaborates with faculty on the development of their proposals. She consults with individual faculty on grant preparation and she attends faculty meetings in all of the different departments to help provide information regarding institutional support for proposal writing. This support from the grants officer is a key part of the model—an integral part of the Institution-Wide Reform initiative.

Thus, there is institutional support for the process of institution-wide reform. We take the institutional mission and apply it across campus for funding opportunities. People who participated in the process have gone on to get their own proposals written and some have succeeded in getting grants. The model is working, because the number of grant proposals—written and funded—has increased. Additionally, we have created a new policy in the faculty policy manual on the role of faculty involvement in securing grants.

We established a faculty center for learning development, where members of the faculty can come together and talk about cross-fertilization, pedagogy, systemic reform, and so on. This allows us to support more operations, including research grants, stipends for summer work by faculty, and reunions to celebrate our accomplishments.

We have had an impact on the role of institutional research. Faculty are involved in data collection to assess the impact of new initiatives on students.

We want to retain more students in our SMET programs and in the University as a whole. Institution-Wide Reform helps to attract and to retain students.

In time, this initiative will make the University more cost-effective—i.e., in that faculty attitudes about work will improve; the general culture and

academic climate of the University will improve; a sense of empowerment will extend to all participants; and faculty productivity will climb.

Finally, this project is sustainable. The University is committed to a balanced budget. Thus, there should be more resources in 1998-1999. With more resources, we should be able to continue the work started by Institution-Wide reform. Additionally, the success we realized has convinced people that this initiative is working,and now they are even more willing to sign on.

CHRONOLOGICAL LIST OF ACCOMPLISHMENTS	
Focus	***Results***
Appointments	1996–K. Book to Director of Grants and Contracts. 1996–C. Stevenson to Dean of Faculty. 1997–A. Hadad to Dean of College of Engineering & Dean of Ward College. 1997–E. Smith to Associate Dean of Ward College.
Policy	1998–New language in U of H Faculty Policy Manual, Standards for Faculty Rank: "...curriculum development (including but not limited to the development of educational technology), the development and/or writing of grant proposals...."
Programs	1996–Strategic Planning Advisory Team for disciplinary and action priorities.
Facilities	1998–Faculty Center for Learning Development (FCLD: Distinguished Teaching Humanist, College Faculty Development Efforts, NSF Institution-Wide Reform, TLR & Teaching & Learning Subcommittee of SPAT, Grants, and Second Generation of AEC Project.
Tenure & Promotion	1998–Tenured & promoted to associate professor: D. Buckley, H. Haruta, & M. Turpin.

Reformed Courses

Fall 1996

Course	Leader	Number of Sections	Students Enrolled[2]	
BIO122	Cohen	1	33	(also BIO123)
CH110	Workman	2	41	
M110	Haruta	4	260	
M112	Turpin	1	68	
ES141	Smith	4	80	

Fall 1997

Course	Leader	Number of Sections	Students Enrolled
BIO122	Buckley	1	24
SCB190	Roth	1	14
ET111	Canistraro	3	39
ES141	Smith, Alnajjar	4	102
CH110	Workman	3	111
M112	Turpin	1	45
M110	Haruta	5	138

Spring 1998

Course	Leader	Number of Sections	Students Enrolled	
PHH100	Danielson	1		
ES142	Alnajjar	5		
CSB190	Greenwood	2		
PHY120	Townsend	1	30	(also PHY121)
CS114	Armen	1	22	
M145	Decker	1	92	

Project	Leader
CBL Based Lab Projects	Froehlich

[2]Data indicates that number of students enrolled is often larger than number of students who completed a course. CRE was not able to determine these differences accurately.

Presentations & Workshops	1996–Grant Faculty Summer Workshop U of H. 1996–L. Smith, SMET Faculty Seminars on Improving Undergraduate Learning: *Project-Based Approaches to Teaching First-Year Students,* U of H. 1996–L. Smith, Project-Based Approaches to Teaching First-Year Students, U of H. 1996–M. Turpin, A Data Oriented Business Calculus Course, Boston, MA. 1996–R. Radin, Mastermind Convention of the Peoples Network, Dallas, TX. 1996–H. Canistraro & T. Harkin, invitational workshop on Concurrent Engineering, University of Texas. 1996–H. Canistraro, judge, Connecticut Invention Convention. 1996–H. Canistraro, Hardware-Centered Teaching Curriculum in Machine Design, University of Connecticut. 1997–SMET Faculty Seminars on Improving Undergraduate Learning: Technological Literacy: What Skills Do Our Students Need? Learning Roundtable. 1997–B. Beaudin, D. Buckley, B. denOuden, J. Fairfield-Sonn, Teaching with Case Studies, U of H. 1997–Teaching with Case Studies: A Roundtable Discussion, U of H. 1997–Using Student Peer/Study Groups, U of H. 1997–Learning Through Community Service, U of H. 1997–L. Smith & D. Shetty, Principles of Engineering and Design: A Multidisciplinary First Year Course, ASEE Conference, West Point, NY. 1997–R. McGivney & M. Haruta, Towards New Course in Precalculus, Association of Teachers of Mathematics in Connecticut (ATOMIC), Cromwell, CT. 1997–Learning Roundtable, Technological Literacy: What Skills Do Our Students Need? U of H. 1997–M. Haruta L. Pence, & L. Kelly, Using Student Peer/Study Groups U of H. 1997–R. Griswold, S. Morgan, F. Sweitzer, & P. Oliver, Learning through Community Service,U of H. 1997–A. Forlenza-Bailey, Preparing Professional Educators as Reflective Decision Makers for a Democratic Society, Association of Teacher Educators, Washington, DC. 1997–H. Canistraro, J. Dannenhoffer, J. Girouard, P. Katz, A. Lankford, & R. Radin, revision of Ward College's Introduction to Engineering Technology (ET 111), U of H. 1997–J. Dannenhoffer & R. Radin, Using Multiple Intelligence Theory in the Mathematics Classroom, U of H. 1997–M. Haruta, Revitalizing Precalculus with Labs and Real Life Data, Bridgeport, CT. 1997–M. Haruta, Creating Activity-Based Lessons for Algebra and Precalculus, Waterbury, CT. 1998–L. Townsend, R. Radin, & A. Hadad, Relevance of Physics to Engineering Technology Education, ASEE.

Presentations & Workshops	1999–H. Canistraro et al. A New Approach to the Introduction to Technology Course at a Four Year Engineering Technology College, Proceedings of the ASEE Annual Conference, Charlotte, NC.
Awards	1997–Patent for X-Ray Based Extensometry Device for Radiography. 1997–NSF Project Kaleidoscope to H. Canistraro. 1997–Distinguished Educator Award from Physics and Engineering Physics Division of American Society for Engineering Education to A. Hadad. 1998–Outstanding Teacher Awards to J. Bonaca (HCW), D. Buckley (A&S), H. Goldnick (A&S), L. Pence(A&S), and R. Radin (Ward).
Journal Articles	1996–G. Fralick, H. Canistraro, D. Pease, & E. Jordan, Progress in X-Ray Based Displacement and Strain Measurement, *NASA Laser Tech Briefs.* 1996–H. Canistraro, E. Jordan, Projectile Impact Location Determination through the Measurement of Acoustic Waves, *Journal of Measurement.* 1997–M. Haruta & R. McGivney, Geometric Probability and Modeling, *The Mathematics Teacher.* 1997–A. Srnivasan, D. McFarland, and H. Canistraro, Embedded NITiNOL Actuators to Obtain Increased Bandwidth in Structural Control, *Journal of Intelligent Materials and Structures.* 1998–M. Stevens, A Study of the Thermal Cure of a Phenylethynyl-Terminated Imide Model Compound and a Pyenylethynyl-Terminated Imide Oligomer. *Journal of Polymer Science.* 1998–H. Canistraro, E. Jordan, and S. Shixiang, Elastic Constants of Hastelloy X at Elevated Temperatures - An Ultrasonic Technique, *Journal of Engineering.* 1998–H. Canistraro, G. Fralick, E. Jordan, and D. Pease, Measurements at High Temperatures, *NASA Laser Tech Briefs.* 1998–H. Canistraro, D. Pease, and E. Jordan, Differential Displacement Measurement Using Scanning X-Ray Beams. *Review of Scientific Instruments.*

Grants	1996–NSF, Institution-Wide Reform, $200,000 1996–NSF, Biology Research, $47,000 1996–AAC&U, Women & Scientific Literacy, C. Stevenson, $75,258. 1996–NSF, A Technologically Advanced Environment to Promote Scientific Interest & Literacy in Under-prepared 1st & 2nd Year College Students, R. Roth, $69,933. 1996–Auto-DESK, Inc., software and documentation to H. Canistraro, $6,000. 1997–ANYSYS Corp., software, H. Canistraro. 1997–NSF, A Team Approach to Developing Multi-disciplinary 2 Year Experience Accentuating Lab Science and Technology for Under-prepared College Students, R. Roth, $55,011. 1997–Junior League, Saturday Science Sampler-CT Girl Scout Council, Thatcher, $31,467. 1998–FIPSE, Achieving Effectiveness & Efficiency of Student Learning Through Integrative 1st Year Interest Groups, Collaruli, $334,482. 1998–NSF, Integrating Engineering Design with Humanities, Social Sciences, and Science & Mathematics, Shetty, $1,415,058. 1998–NSF, Partnerships for Science/Math Excellence, H. Workman, $2,006,615. 1998—NSF, ILI Multi-Use Computer Based Data Acquisition System, H. Canistraro $16,500.
Course Reform Projects and 1998 Mini-Grants	*1997* Arts & Sciences, Chemistry, CH110 College Chemistry, H. Workman. Arts & Sciences, Biology, BIO 122/123 Biological Science, D. Buckley. Arts & Sciences, Mathematics, M110 Precalculus, M. Haruta. Arts & Sciences, Mathematics, M112 A Short Course in Calculus, M. Turpin. College of Engineering, ES 141/142 Principles of Engineering & Design, L. Smith. Ward College of Technology, ET111 Intro to Engineering Tech., H. Canistraro. Hartford College of Women, PHH100 Intro to Physics, B. Danielson. Supplemental Instruction, M. Haruta. *1998* Arts & Sciences, Physics, PHY120/121 Physics, R. Radin, L. Townsend, A. Hadad. Arts & Sciences, Mathematics, M144/145 Calculus I & II, R. Decker. Hillyer College, Biology, SCB190, Concepts of Science, R. Roth. Hillyer College, Mathematics, CSB190 Information Technology, J. Greenwood. Computer Science, CS114, Computer Programing I, C. Armen. College of Engineering, Electrical & Computer, H. Alnajjar. College of Engineering, Mechanical, CBL Based Lab Projects, J. Froehlich. Supplemental Instruction, M. Haruta.
Internet	http://morpheus.hartford.edu/math/faculty/mharuta/individ.html

Data collected by CRE,during interviews with co-principal investigators and documentation from the project's files and web site,provides strong support for the conclusion that Institution-Wide Reform has realized a high level of success in its two-ear existence at the University of Hartford. Additionally, as the next section indicates, data that CRE collected during interviews with other study participants—namely,faculty assigned to different SMET disciplines, staff, and department chairpersons—and related documents provides additional evidence that this grant is well-designed, is effectively administered, and is a benefit to its target audiences.

B. Faculty

This section presents the perspectives of faculty regarding Institution-Wide Reform. The study participants are professors—including department chairpersons—from different SMET disciplines. The different subcategories reflect the project's emphases and faculty concerns. The Engineering Department provided a useful example to illustrate a department-level response to the initiative. Thus, it receives separate treatment.

Faculty Collaboration

Institution-Wide Reform brought faculty closer together. Workshops sponsored by the grant were very valuable. They attracted people from a wide variety of places on campus. Actually, it was very effective that way. Faculty from chemistry, engineering, mathematics, biology, technology, and different colleges all joined forces to work at improving the introductory courses. The grant literally forced us to meet. We were given the responsibility to get the proposed job done and we had to report on the results.

We would not have done this work without the grant. Faculty normally do not meet on a systematic basis to study their methods of teaching. However, the grant strongly encouraged that kind of work. It brought together faculty and administration for the purposes of developing and implementing curriculum changes.

This grant has been accepted by the faculty because it coupled pedagogical innovation with institutional change. However, the innovators are not the outliers. Faculty who participated realized freedom to introduce changes.

Impact on Students

This restructuring initiative improved our ability to engage students in a meaningful way of learning, regardless of their level of sophistication with the content. We employ an active learning pedagogy, which has increased students' involvement with the material. For instance, we have established research labs where students become involved in original research questions.

We are very satisfied with students' response to these changes. For example, prior to the grant, only the top-level students participated in the research assignments. Now, the response is more widespread.

We recruited talented students to serve as peer tutors in the SI program. These are students who have already taken the course and who did well. We have structured it so that there are rewards for the students to interact with their peer tutors. Basically, they get percentage points for the upcoming exams. The peer tutors provide good role models for the beginning students.

Impact on Pedagogy

Cross-disciplinary activity sponsored by this grant has enabled faculty to become much more aware of the teaching methods that different professors use. Lecturing was the predominant style. Now, classroom practices are beginning to include more group work, technology, real world applications,

and problem-solving. For example, as evidence of our success, we can show that previously we had a 60 percent retention rate for students in the entry level biology courses. We now have a 90 percent retention rate. Unfortunately, we have not analyzed data on student performance.

Freshman Level Courses

There were a lot of senior faculty who did not want to work with the freshmen. Now, that preference is being turned around. The new courses that we have developed are seen as much more challenging than they once were.

What motivates faculty and leads to good results is the collective interest and work at the lower level courses to raise the quality of work there. As a faculty, we have to acknowledge that we are not happy when the results—such as attrition rates—are not what we want. When we think about those issues honestly, we realize that something has to be done to change the outcome. That realization is what motivates faculty to take action. They all want to be associated with a good program. They know that good students are attracted to good programs. In the end, everybody benefits.

Technology Applications

Several years ago, the mathematics department required its students to use the graphing calculator and CBL. Thanks in many ways to this grant, other areas, including science and engineering, are now using these new tools. That is one way we are able to coordinate and integrate the curriculum across different disciplines.

Assessment of Impact

There is a need for working on the faculty culture in order to determine the needed learning goals and pedagogy to accomplish changes. Additionally, we need to do the kind of assessment that allows us to see if we have changed students' learning. If we don't examine the impact of our curriculum and methods on students' learning, we will never know if the changes we introduced had positive implications for the students.

Example: The Engineering College

1. Teamwork. An important selling point of this grant is its emphasis on team work and group learning activities for faculty and students. We assign faculty to teams, based on their commitment to learning new teaching methods and on their commitment to teaching freshmen. If somebody is not really committed to these changes, they are replaced by someone who is interested in this work. One of the first things we had to do was to change faculty attitudes about how to attract and how to keep students in our degree program.

For example, faculty in the Engineering Department found that its students used to go into engineering without understanding what engineering is. The freshman year included a one credit introductory course, a two credit

engineering graphics and programing course, and a three credit engineering statistics course. We realized that the students were not getting a clear idea of what engineers do in their careers. The courses led the students to think about engineering as mathematics and physics. We wanted students to understand that engineering is the *application* of mathematics and physics and includes group processes and problem-solving.

To address this issue, the department met to discuss revising the entire engineering program. Full time faculty, not adjuncts worked on this, which shows how important this change is to the department. Institution-Wide Reform supported their work.

We designed the new three credit engineering course collaboratively. We defined the outcomes we wanted and planned the course to accomplish those objectives. We modified the program to eliminate things that did not work well for the freshmen students. The course is updated regularly by the faculty.

Now, by the time the students finish the three credit course, they have a firm knowledge of the engineering fields. They are able to select a major with confidence or to elect to drop out of the program and enter a different field of study that is more aligned with their career interests. Thus, students' decisions in regard to their college education are based on knowledge instead of rejection or failure.

2. Impact on Engineering Students. Our engineering students have realized the benefits of this revision. When they leave the new course, they carry some of the things we did with them at the freshman-level to their sophomore- and junior-level courses. Key results for these students' are preparation in teamwork, cooperative learning assignments, and problem-solving. We are now able to observe the benefits in the students' junior level lab work. They get into the teamwork much more quickly than in the past.

3. Cross-Disciplinary Collaboration. This grant supported teaming of faculty from the Engineering Department with faculty from the English Department for a program known as the Freshmen Interest Group (FIG). Professors describe the engineering and English courses as "locked together," meaning that the same engineering students attend courses in both departments and that there are overlapping assignments. The English professor's focus concerns developing students' skill with context, writing, and presenting. The engineering professor emphasizes knowledge of technical aspects. The structure of the course enables professors from both departments to track individual students and to observe differences across groups of students. Thus far, results indicate that the engineering students are more responsive to the course requirements. The Engineering Department plans to develop similar collaborative courses for mathematics and physics. These initiatives will lead to greater cooperation between the University's engineering program and the humanities program. Continued expansion of courses and teams in this manner will support the "All-University Curriculum," which 80 percent of the

engineering faculty would like to see happen.

The current revisions in the All-University Curriculum (AUC), which was started in 1987, are related to the Institution-Wide Reform initiative. The AUC was begun in 1987 as an "institution-wide reform" supported by a grant from the Mellon Foundation. The process by which it was created parallels the process used in the NSF Institution-Wide Reform grant. Over its ten year life, the AUC has forged and sustained the kind of cross-collegiate partnerships that the NSF grant is also working to achieve. AUC courses are constantly undergoing revision and new teams of faculty are brought together to create new offerings or to revise current ones.

Also, the NSF grant supported a week of workshops in which faculty from different departments and programs talked about their courses.

Through these open discussions, engineering faculty understood that some of the methods and materials they were using were not as effective as they should be. We discovered that, when faculty don't interact across departments and programs, they think the way that they do things is the only way or the best way. Through discussions with other faculty, we saw there were important differences in methods of teaching. This dialog on our teaching practices did not occur prior to the grant.

We had introduced related changes in the Engineering Department prior to Institution-Wide Reform, but we benefitted from the grant's support. We would not have met other faculty members. The grant was a very effective way to bring faculty together. It enabled them to get support for release time, to coauthor professional articles, and to collaborate on workshops.

4. Overall Impact on the Engineering College. As a result, our basic vision of teaching freshmen changed for the better. We increased the students' credit load, moved physics to the second semester for freshmen, and incorporated more material in the first semester freshman experience about engineering and what is expected of engineers. Now, in our engineering courses, we discuss engineers and what they do. We bring in practicing engineers from different companies and have them speak about their work to the students.

We retain more students at an early point in their college career—especially really good students. When they meet practicing engineers, they say, "That's what I want to be." The results for students are much better. We are beginning to notice the differences in the higher level engineering courses.

Our engineering students learn computer skills. In fact, they are better prepared in computer applications, especially web page authoring, than other students. As a result, our students are in demand by other departments.

This change in the Engineering College has been institutionalized. The faculty and the administration realize that what we have been doing for the past few years has to continue. It is working—for the students, for the faculty, and for the programs. We will continue doing our work in this way because we

believe in it.

Additionally, this work will continue regardless of budget issues, because our Dean is very supportive. He has assured us that, if the money is there, we get it. If the money is not there, we will look elsewhere for support, and the administration will help faculty search for that support.

When you see people—such as the administration and the faculty—who are involved in an initiative and who want it to continue, it is a good sign of success. These people are not saying, "I'm out of here," when the grant is over. We want it to continue. It will continue.

As indicated previously, professors and department chairpersons in SMET disciplines have a highly positive opinion of the concept and implementation of Institution-Wide Reform. The example above from the Engineering Department helps to illustrate the benefits for faculty, programs, and students. Additionally, faculty share a common expectation that the positive changes introduced by the grant will continue.

C. Courses

Next, CRE examines study participants' perceptions of the grants' impact on SMET courses. Technology applications, problem-solving, and real world applications are the main effects. Ward College provides a focused example of the grant's impact on an academic unit.

Chemistry

The chemistry lab has been changed to affect all students. In particular, the graphing calculator, CBL, and other projection systems are now the main tools that we use to help students think through problems. That is a significant change that came about as a result of this grant.

Mathematics

The calculator has been a significant tool in the Mathematics Department for a long time. However, support from this grant gave the mathematics department more time to revise its courses and to shift away—for particular purposes—from a theory-laden approach to practical applications that are focused on careers, such as business. To ensure a successful approach, the math faculty met with the business faculty on this issue of course revision. Now, students from various majors can study calculus with real life examples drawn from the world of business. Previously, these same students would have had a difficult time understanding the theory. Now, they have the skills to appreciate the application of calculus to business interests.

The mathematics department would not advise students to take this particular calculus course, unless it is the final course for their major. If the students' major requires substantive treatment of mathematics theory, then we advise them to take a set of 4-5 math courses.

Other SMET Disciplines

Soon, these changes in methods and emphasis will spread to the physics and biology departments. Nevertheless, even now more professors, who teach SMET courses, use cooperative learning exercises in their classrooms.

Some professors have started to use e-mail dialogs to supplement face-to-face meetings with their students. Professors use the Internet to post course syllabi, to administer and report the results of exams, and to assign problem-solving lessons when studying in the SMET disciplines.

There is now more uniformity in the students' experiences across introductory SMET courses. Faculty see the benefits of students' direct involvement with real research projects. Also, students are talking about the results that they obtain in their projects.

Ward College

Institution-Wide Reform is the first grant we received that gave us the opportunity to look really hard at the longstanding problems with the content and the delivery of our curriculum. Faculty are inclined to take offense at questions about their pedagogy.

1. Introduction to Physics. In Ward College there was a three-semester physics course that had been compressed into a two semester course, known as Physics 120 and Physics 121. Our students are hard workers, but they are often ill-prepared for college. That change simply provided too much material to cover in the limited amount of time—e.g., imagine that there were 100 topics, but there was only time to cover 70. If the professor tried to explain the physics topics or tried in other ways to help the students understand the material, he or she couldn't get through the course.

We were turning students off. They were overwhelmed with the material. The evidence was staring us straight in the face, and students were dropping out of our courses. The Dean had lines of students outside his door who were freaked out and ready to quit college.

This particular physics course is what is known as a service course. Students from a variety of majors would take it to satisfy their physics requirement. Having the physics course scheduled for the freshman year means that the students will be scientifically literate at the beginning of their college education. A student has to understand physics in order to work in engineering and technology fields. For instance, if students simply learn a set of skills for the use of technology today and they don't know physics, those skills will be outdated by the time they graduate from college. The technology changes so rapidly. Knowledge of the basic principles of physics is critical for a successful career in science, mathematics, engineering, and technology. Thus, this course is critical.

The grant gave the resources and the focus that we needed to improve this situation. We surveyed the faculty to find out what most people agreed were the critical topics. the faculty worked together to rewrite the goals and the focus for the course. We prepared new materials to explain how formulas explain natural phenomena, such as wave motion. We did all of this work more systematically than we would have done without the inspiration of the grant. The collaboration among faculty was very helpful; it was very valuable.

2. Rationale for Changes. Why is this course revision important? In a university, academic integrity has to be a first priority. In our college, physics is very important for students who major in technology. What is taught in physics and when it is taught are critical questions.

Additionally, we are concerned with the number of students who pass trough our doors and later decide to attend graduate school. Not long ago, technology was seen as a terminal degree—i.e., something you got prior to

entering the world of work. Now technology is a path to graduate school in engineering.

Math and physics also have been the biggest reasons for student attrition in Ward College. This has been a real problem for us. If we accept students, we should work hard to retain students. We should not have courses designed in such a way as to drive students out.

We have to be careful who teaches the introductory courses. We assigned some of our best teachers to teach the physics courses. The results are highly positive.

This revision of the physics course would have been very difficult to do without the support that we received from the grant.

3. Results. Students' retention is improved. There is greater use of computer applications. Courses in the college are team taught. Assignments involve cooperative learning, so students get acquainted quickly and learn how to work together. Overall, the course revisions in Ward College have had an impact that we want to see on faculty and students. There is a desire to come to class. Not long ago, our freshmen did not want to come to class. Even, when they were present, their attention span was minimal. Apparently there were other things that they wanted to do instead of being there.

4. Related Changes. As a faculty, we met once per month to share ideas on another course in the college, ET111, Introduction to Technology. We assign a different faculty member on a rotating basis to teach the three sections of that course. Thus, everyone in the college will be familiar with the course, and everyone will have a chance to contribute to its development. We have used this process to win over people who thought the course was a waste of time.

Now, the faculty report that the students are better informed than in the past about SMET careers. Another important related change is that students are talking with faculty more often.

5. Overall Impact on Ward College. Anything that we do to take another step forward with our courses is very good for our students, for the university, for the department, and for the faculty. The image created by the revised physics and technology courses is that we are doing our job right. Students are learning, enrollment figures are increasing, retention is up, and fewer students are requesting tutorial assistance. Our success has taken us all to a new and a higher level.

This analysis has demonstrated that study participants have a positive opinion in regard to the grant's impact on SMET courses. Whenever faculty talked about the courses they teach, they always expressed concern for the implications for students. Also, one of the main findings in this evaluation is that faculty express great relief that, at last, something—in this case Institution-Wide Reform—forced them to work together on the mutual problems of rigid pedagogy, gatekeeper courses, and low-technology curriculum.

D. Administration

In this section, CRE presents two differing viewpoints on University administration in regard to implementing the broadly-based concern for institution-wide reform, in general, and in regard to implementing the grant, specifically. We begin with the administration's perspective on institutional reform and continue with the faculty perspective on university administration and on institutional reform.

Administration's Perspective on Institutional Reform

Institution-Wide Reform has been a successful initiative. The right faculty are involved. Its key features are developing cross-disciplinary teams, learning to listen to each other, and learning to work together. Now, there is definitely an upbeat attitude regarding reform, because what you get with a team is somebody in your area or a related area who you can talk with about common concerns.

We want to produce graduates who know how to work with others. If we succeed in that, students who graduate from the University of Hartford will have less ramping up to do once they get to their new jobs.

The implications for the faculty are they will learn that they are no better than the best and that more work is produced from cooperative than from independent work. To do this, we need people with interdisciplinary abilities and interests. The new faculty that we hire come here with these skills and attitudes.

1. Results. We are pushing interaction across all nine colleges in this University. Previously, the faculty didn't know each other. They were holed up. We are striving to widen the circle of people who are working together for institution-wide reform. There is better articulation now in cross-collegiate teams than in the recent past.

One of our current goals is to revise the All-University Curriculum. At this time, only certain faculty are involved in this work. Our approach is to build the team, first. Then the team can do the curriculum planning. We are hoping to change the entire faculty culture to cross-collegiate teamwork and to work with interdisciplinary courses and majors.

One of the main issues is figuring out a way for people to satisfy their work requirements while they work on reform issues. A main incentive for faculty involvement in the planning, at least, is reduction in teaching responsibilities.

2. Outlook for the Future. What we have accomplished thus far will continue. We have established policy on programs and courses. Next, we have to work on the rest of the faculty. Also, recently we received another NSF grant and a FIPSE (Fund for the Improvement of Post Secondary Education) grant which should help to keep up the momentum.

At this point, CRE shifts attention from the administration's perspective to the faculty's perspective on the administration and Institution-Wide Reform.

Faculty's Perspective on Administration and Institutional Reform

1. Implementation Stage. At first, the innovations we introduced in our department were part of an institution-wide effort to have top-down and bottom-up reform. The faculty was given the go-ahead by the administration to introduce changes and to take risks. The support and the leadership that faculty needed were there.

2. Perceived Shift in Focus. However, as time went on, the university administration adopted a strategic plan which moved faculty farther away from direct involvement with questions about institutionalization. The faculty committee, established for decision-making about technology purchases for that purpose, was disbanded. The innovators were removed.

Currently, there are several very small, exclusive committees for infrastructure development. From the point of view of some faculty, that is not the way to go. Instead, continuation of the reform initiative should be more widespread, it should be formative in its orientation, and it should support risk-taking.

The main explanation for this change regarding faculty involvement with institution-wide reform is style—a preference on the part of university administration for top-down decision-making rather than collaborative decision-making. Faculty continue to exercise high-level academic freedom regarding their curriculum..

3. Impact on Faculty. Thus, some faculty who have invested themselves in the Institution-Wide Reform grant, have the sense that they are being held back by the administration. They feel that the administration does not allow the faculty to have a say in regard to changes—as the faculty should. These faculty report that the administration will say no, so there is no discussion.

4. Problems with Red Ink. The university has just emerged from difficult financial times. In the process, there have been some difficult and painful choices made. These were hard choices. There wasn't always enough money to go around. There were philosophical differences on what proposals to choose. If a particular proposal is turned down by the administration, the only option available to the faculty may be to apply for a grant from an outside source. The administration's decisions about which proposals to accept are not always understood by, or acceptable to, faculty.

5. Outlook for the Future. Will faculty and students be at the center of this systemic reform initiative? It is too early to tell. Faculty will say that a common statement from the administration is that there is not enough money to support proposals. However, from the faculty perspective, the truth is that we don't get to say what the money should be spent on. Too many of the decisions are made by the upper level administration.

Furthermore, the faculty say that the different colleges and the faculty and the administration have not "fused together" to create a singular identity across campus. This grant has more work to do on the model it created and on the systematic applications of the model across campus, so that everyone knows about it and is on board, supporting full-scale adoption.

The grant's noteworthy successes notwithstanding, the reform initiative has not integrated us in a way that it was intended to do. Different colleges and different individuals continue to do their work as usual.

Notwithstanding the overall success of Institution-Wide Reform, there are nonetheless important differences in these two perspectives from the administration and from the faculty.

On the one hand, the University administration acknowledges the value of Institution-Wide Reform and the real contributions it has made, thus far, toward changing University policy and teaching practice. However, the administration also expresses concern for getting the right people in positions of responsibility vis-à-vis the institutional reform stemming from the grant. The administration's use of the word "we" clearly signifies the administration. The faculty are "they," but in two groups—those who are selected and those who are not selected to participate in the decision-making process.

Additionally, University administration clarifies that no faculty committee related to reform of SMET has been "disbanded." In fact, several have been created. The only committee that faculty might refer to in this context is the ACAC committee which was disbanded in 1993-94. ACAC was a faculty committee that was allocated money to purchase technology, but it was disbanded when the university enrollments declined and when it became clear that a more coordinated approach to technology acquisition was necessary. There are faculty committees (one very large and open to all faculty and staff; one with representatives from various campus constituencies, including two faculty representatives) which make recommendations to the Strategic Planning Action Team about technology acquisition.

On the other hand, approximately 25 percent of the University faculty that CRE interviewed for this study—while acknowledging the grant's implications for supporting innovative teaching and direct involvement with institutional reform—convey disappointment at their perception of a recent shift in focus by the administration. In the previous analysis of data, it is clear that the faculty also think of their relationship with the administration in terms of "we" (faculty) and "they" (administration) categories. This is a typical and a useful social construction for the workplace.

However, faculty express both concern and regret that the process of institution-wide reform has changed, in their opinion, from broadly-based collaboration to selective committees. From the faculty perspective, the greatest challenges in the immediate future for Institution-Wide Reform are:

- to fuse together all faculty;
- to fuse together the faculty and the administration;
- to make the model work; and
- to create a singular, positive identity campus-wide.

CRE concurs with the faculty's assessment, especially regarding the outlook for the future. Also, in previous sections, CRE's analysis of data from faculty and administration reveals that the administration's concern for "working on the other faculty" is legitimate. In other words, most participants acknowledge that there are some people who are resisting or who are choosing not to get "on board" the institutional reform initiative. Reform activists in both groups realize that the longer some faculty choose to remain uninvolved, the longer it will take for systemic change. Thus, full realization of the model will be postponed until the indefinite future.

However, in this early phase of the reform initiative, some participants may not yet understand or accept the essential conditions of effective collaboration. It requires every partner to have a willingness to give as well as a readiness to receive. Constructive criticism should be valued and complaints should be silenced. Despite expressing sincere interest and doing hard work, everyone must realize that the end result might be failure to obtain a particular objective. Thus, patience, determination, effective communication, and understanding are also important keys to successful collaboration.

CRE concludes that there is enough positive sentiment about reform, enough commitment to the University, and enough innovative ideas regarding teaching and learning among all of these study participants—administrators and faculty. The situation calls for more vehicles and more varied opportunities for everyone, who believes in reforming the institution, to do the work that must be done and to receive appropriate recognition and reward for their efforts. Additionally, faculty and administration should create new methods to help other faculty get on board to build a new and better institution of higher education. They should collaborate to establish policy not to renew people who refuse to cooperate in this important endeavor.

E. Students

At this juncture, CRE presents faculty impressions of the impact that Institution-Wide Reform has had on students enrolled in SMET courses. Later, we examine quantitative data on student enrollment patterns and attitudes towards SMET courses and careers.

Changes in Pedagogy

> The grant is a very positive development for the University, because it is responsible for initiating pedagogical changes and for spreading these different methods and technology applications across campus. However, it is difficult to get faculty to think about pedagogical innovation. Professors are trained to

deliver content. The traditional style of teaching produced students who could give back the derivatives, for example, but they were unable to apply the results to a real world problem. In other words, we made them good at spitting out the rules.

Our science labs are now performance-based, which includes coaching and write ups on various aspects of the process. Our evaluation of the students' lab reports indicates that they have a better understanding of the scientific process. Previous to the grant, the students had no training on these things.

SMET Students' Response

Anecdotal information from students indicates clearly that they want the changes we are introducing. Students have indicated to the faculty that they have a better understanding of the formulas and principles because of the group problem-solving activity, the technology applications, and the real world research.

Some of our students are up-to-date on technology, but they find that their professors are not. As more and more students develop their skills with technology use, pressure will be on the faculty here to incorporate computers and graphing calculators in their courses.

Assessing the Impact on Students

Measuring learning outcomes is not what we—faculty—are trained to do. University faculty will think of exams as a ranking tool. They will not think of creating tests to use as instruments that support useful dialog between professors and students.

At this point, we have learned to ask how to teach better. Now we have to learn to ask how to measure the outcomes. Too much of what we do in higher education is a result of talking about what we want to do. We need to build in assessment for feedback and quality control. Basically, faculty need to start measuring students' learning as an end result of teaching.

We are using the biology section of the SAT to pre- and post-test students. Some professors are not excited about that procedure. Some would prefer to use the GRE. In other words, we don't agree on assessment, and we don't have a systematic or standard way of assessing freshman students in the SMET disciplines.

The students' grades seem to be better than one year ago. Students' interest in SMET courses seems to have improved. But we have not conducted a study of this project to examine its impact on students.

Therefore, most of the information about the impact of these changes on students is anecdotal. There is a paucity of student assessment. Several years ago, the mathematics department did a study of the impact on students' learning when they introduced graphing calculators. The results showed no significant difference with basic skills. Thus, we don't know if these new

changes we introduced have contributed to a significant difference in students' performance, particularly regarding basic skills.

Documentation collected by CRE regarding the grant's impact on students' learning, shows positive effects, although much of the information collected by faculty, thus far, is anecdotal. The shortage of information is because the grant was implemented recently and has had only two years of development. In other words, there has not been enough time to examine results systematically over different cohorts of students.

Institution-Wide Reform included surveys of students' perceptions, which were administered before and after completing SMET courses, and analysis of student records. The initiative received cooperation from the University's Center for Institutional Research to design the surveys, based on what faculty wanted to assess. Data from both sources was analyzed according to reformed and unreformed courses, ethnicity, gender, age, and registration status. There is some evidence to indicate that students' attitudes toward SMET courses were influenced by some faculty. Data indicates that the high school courses that are taken (college prep level) and the study habits of male and female students influence their performance in college courses. However, as the following section on analysis of quantitative data reveals, there was no significant difference between reformed and unreformed courses in regard to students' attitudes and performance in SMET courses.

In order to measure the impact of institution-wide reform initiatives and to attribute changes to particular intervention strategies, CRE encourages NSF to strengthen its requirements for, and its support of, external assessment and evaluation studies. The institutions that are undergoing systemic reform are usually not familiar with these assessment procedures and are not able to supply the resources and the staff for this work. There should be a special emphasis placed on collection of baseline data about student characteristics—including demographics, previous academic records, and current attitudes about, and perceptions of, SMET courses—and on systematic collection and analysis of subsequent course enrollment and performance data on a long term basis. Additionally, CRE strongly recommends that the assessment process incorporate a nonintrusive, standardized, performance-based instrument to measure all SMET students' learning of core content at certain intervals. This could be done at the beginning of the students' enrollment in SMET courses and at the end of their second and fourth years of study. Regular analysis and debriefing by the evaluator of student performance data should be used to identify strengths and weaknesses among students, courses, and programs. There should be monitoring of students' course taking patterns, attrition rates, and selection of majors. Follow-up activity should involve the reform initiative's key personnel in data-based decision-making for strategic planning in order to revise courses and programs and in order to provide professional development.

Faculty acknowledge their deficiencies with regard to measurement of student performance and with regard to using students' learning as an indicator of teaching and program effectiveness. Additionally, many of the university faculty—like their counterparts who teach at Pre-K through grade 12—are not ready to hold themselves accountable for producing positive or negative results in the teaching and learning enterprise.

In this initiative's next phase of development, key partners should focus attention on improving faculty's appreciation for accountability. Also, workshops should develop faculty's

understanding and skill with using limited, but systematic, assessment of students' learning. A sustained inquiry would establish baseline data and eventually would provide meaningful correlations between differences in students' performance and varied treatments—or changes—in the curriculum and instruction for SMET disciplines.

F. Institution

Finally, CRE provides analysis of study participants' perceptions regarding the extent to which Institution-Wide Reform has contributed to systemic change at the University of Hartford. Key resources include faculty, department chairpersons, staff, administrators, and co-principal investigators.

Faculty Work

At the department level, faculty members who focused on pedagogical innovations supported by this grant are enormously proud of the results.

Institution-Wide Reform has promoted interaction between faculty from different disciplines. Previously, we never had formal, cross-disciplinary interaction. The standard procedure was different individuals pursuing their ideas independently. However, the grant sponsored meetings between these various faculty members in the different SMET disciplines.

This initiative has had a positive influence on risk-taking by the faculty. University teaching in the new model presented by this grant is more time-consuming, more intensive, and requires a level of comfort with the use of less orthodox procedures.

The faculty handbook has been revised to include language which recognizes service related to this reform initiative as acceptable for decisions regarding tenure and promotion. Not everyone is involved, but there is representation from every SMET discipline.

Professional Development

The grant's workshops on students' learning styles were very attractive to our faculty. For example, after examining the results of Howard Gardner's research on multiple intelligence, the faculty underwent a significant change—i.e., they improved their attitudes about students' learning. Additionally, as a result of this grant, faculty improved their knowledge and their skills with technology use.

Revision of the All-University Curriculum took place as a result of this grant. These professors involved in that program are known as real innovators. The design of the program facilitates intellectual discourse for cross-disciplinary interaction. The professors have to articulate what they mean by their concepts to faculty from different departments. Ordinarily, cross-disciplinary discussion would not occur.

Also, success with this grant enabled us to pull in a number of additional grants from private and public sources. All of these initiatives are based on a common interest in fostering an active learning environment for our students.

Long-Term Issues

Some individual faculty members have benefitted from this grant, and that is a good result. However, overall the gains have been modest, particularly when considering long-term impact. It is very hard to change the culture of a university. One, two-year grant is not enough. We still work according to the old system. Once a semester starts, we don't see anyone else until it ends. That has to change.

The university doesn't do enough with faculty, course, and program development. There is usually a lot of talk about doing something but very little action. It's hard to get people at a university to agree on anything new. If they buy into the change process from the beginning—great. They are on board. If not, then the initiative might not succeed in the long term.

Thus, one of the stumbling blocks with this grant is getting the rest of the University to partake. The key participants want to export new ideas. However, that is a hard task because it takes a while for the change to happen. Institution-wide change—when it's taken seriously—can take a long time.

The slow process of change can make the people who want it to happen get frustrated.

The grant's design called for implementing the changes by giving workshops. However, one of the problems with using workshops is that the same people show up all of the time. Another issue is that there will always be resisting faculty. They will resist the process as well as the initiative itself. Also, something like Institution-Wide Reform, has to get approval from the entire faculty. There were some who spoke out against it.

For some faculty, the choice of participating or not wasn't an issue, because they are tenured. However, younger, nontenured faculty have to make the choice to get on board or to wait and see what happens. Either way they could have trouble.

Overall Impact on the Institution

> Overall, this Institution-Wide Reform grant is successful because it brought together people from different areas of our campus. There was high level cooperation and exchange of ideas. The people who worked on this initiative understood that there was a lot of work involved. There would be risk-taking, and yet they chose to get involved. Also, there were problems, but there was no significant blockage.

The analysis of data regarding the impact of Institution-Wide Reform on the institution itself reveals an overall positive rating, with mixed results for long-term impact. On the one hand, study participants report that this grant has significantly influenced the institutional support for, and the use of, innovative teaching practices. Participating faculty are generally pleased with the results for themselves—both collectively and individually—and for their students.

The grant's offerings for professional development have enhanced faculty's perception of the classroom interaction paradigm, helping to shift from a predominantly teacher-directed approach to a student or client-centered approach involving collaboration, problem-solving, technology use, and real-world applications. Faculty realize that the new process of teaching requires more work, is more intense, and entails more interaction with students and colleagues. Nevertheless, participating faculty embrace the model because they realize that it has positive implications for their perceptions of themselves as effective teachers and for their students' learning.

On the other hand, study participants also recognize that the scope of the problem with institution-wide reform is very large, including some troublesome historical components, such as tenure and promotion. CRE concludes that the faculty's appraisal of the grant's long-term impact is realistic, in that it acknowledges the facts and, thus, presents both the hopeful and the sobering aspects of systemic change at the University of Hartford.

In the main, the critical areas for institutional change are personnel and policy issues. The long-term solution will require a substantially different University personnel policy. Achieving that result will require strong, continuous leadership; collaborative, but firm decision-making; ongoing professional development; accountability for results, and new personnel policy.

G. Summary

CRE's analysis of qualitative data shows that study participants

- express a high level of agreement overall.
- have positive perceptions about the Institution-Wide Reform project at the University of Hartford, in general.
- have positive perceptions about the program's impact on faculty, courses, degree programs, and students, in particular.
- express widespread approval of the project's concept, design, and implementation.
- indicate their high level appreciation of work done by Mako Haruta and Catherine Stevenson, the project's co-principal investigators.

The two main issues identified by a majority of participants, especially among faculty, are the

following:

- increase the commitment to institution-wide reform from the faculty and the administration; and
- place more emphasis on analysis of the initiative's impact on students.

CRE's analysis of data indicates that the University has taken action on both of these issues, especially in regard to the development of proposals and the pursuit of significant dollars in external funding to support ongoing institution-wide reform. Documentation shows that, since 1996, the University has secured nearly one million dollars in grant money that is directly related to reform of SMET.

The analysis of quantitative data follows.

2. Quantitative Analysis

The following section presents a report on the results of the analysis of the University of Hartford science, math, engineering, and technology (SMET) courses survey data.

The analysis was conducted to determine the effect, if any, of certain stipulated factors on the overall performance (GPA) of students in SMET courses. The analytical technique involved mainly multiple regression analysis and the use of simple statistical tools, such as histograms and line graphs. The results of the analysis are discussed in detail in the following pages.

A. Methodology

The raw data received from the office of institutional research consisted of data from six survey periods—Fall '96, Spring '96, Fall '97, Spring '97, Fall '98, and Spring '98. The Spring '96, Spring '97, and Spring '98 data were follow-up survey data. The initial surveys were conducted at the beginning of the year (in the Fall semester) and the follow-up surveys were conducted at the end of the year (in the Spring semester). Upon examination of the initial survey data and the follow-up survey data, it was observed that in all cases about 50 percent or less of the respondents in the initial survey also participated in the follow-up survey; many of the respondents in the follow-up survey were participating in the survey for the first time. Furthermore, the period between the initial survey and the follow-up survey was relatively short. No significant change was observed between the two periods in either the attitude or the performance of the respondents in the surveys. A year-to-year analysis would produce more reliable results and more meaningful trends than a quarter-to-quarter (semester-to-semester) analysis. Hence, the analysis was conducted primarily on a year-to-year basis.

The data was sorted by different parameters: reformed and unreformed courses, race or ethnicity, gender, age, and registration status. The data was then categorized by race or ethnicity, gender, and age. The major categories include Whites, African Americans, All Others, males, females, and age categories Age<=19 and Age>=20.

A multicollinearity test was conducted to test for possible correlation between the independent variables. In cases where two independent variables were found to be highly correlated one or both of the variables were not included in the regression analysis.

Using GPA as the dependent variable, separate sets of regression analyses were conducted for each survey period (Fall '96, Fall '97, and Spring '98). The independent or explanatory variables included SAT scores, years of high school science (QI), years of high school math (QII), whether or not a course was an advanced placement course (QIII), a measure of students' attitudes as estimated by the weighted sum of students' responses to the attitudinal questions (Q_SUM), team attitude (TEAMATTIT), number of hours of study per week (Q1_30 or HRS_STUD), a measure of positive attitude (POSATTIT), and a measure of negative attitude (NEGATTIT).

In cases where there was no information on a particular variable in the data set, that variable was not included in the regression analysis.

In the Fall '97 and Spring '98 data sets, there was no information on TEAMATTIT, POSATTIT, and NEGATTIT. Therefore, those variables were not included in the correlation and regression analyses.

In the Fall '96 data set, eight African American students participated in reformed courses. In the Spring '98 data set there were only six African American students, who were fully registered for courses covered by the survey, with only one student participating in a reformed course. Since the number of African American students was not sufficiently large, no regression analysis was conducted for the group in the Spring '98 data set, and no reformed course category was formed for the group in the Fall '96 data set. For the Spring '98 data set the regression analysis was conducted for six groups: males, females, Age<=19, Age>=20, whites, and "Others." The "Others" group include African Americans and all other nonwhite respondents in the survey. Only four of the students in this group participated in reformed courses; therefore, no separate analysis was conducted for reformed course category.

Simple line graphs and histograms were used to delineate the average performance and attitudes of students in the different groups and categories.

B. Regression and Analysis

For each of the survey periods (Fall '96, Fall '97, and Spring '98), regression analyses were conducted by ethnic group, by gender, and by age categories. The major categories include Whites, African Americans, "All Others", males, females, and the age categories Age<=19 and Age>=20. The regression analyses were conducted to determine the effect on students' performance (GPA) of the different explanatory variables—SAT scores (SAT), years of High School science (QI), years of High School math (QII), whether or not a course was an advanced placement course (QIII), the weighted sum of students' attitudes towards SMET courses (Q_SUM), team attitude (TEAMATTIT), number of hours of study per week (Q1_30 or HRS_STUD), the estimate of positive attitude (POSATTIT), and the estimate of negative attitude (NEGATTIT) towards SMET courses.

Analysis by Ethnic Group

For the purpose of this analysis, three ethnic groups were formed: Whites (Caucasians), African Americans, and "All Others." The "All Others" category includes all other nonwhite ethnic groups in the survey data (excluding African Americans for Fall '96 and Fall '97). In Spring '98, the sample size for African Americans was too small to form a separate category for regression analysis and was therefore included in the "All Others" category.

1. Whites. The analysis of the Fall '96 data set for both the regular and reformed science, math, engineering, and technology (SMET) courses showed the coefficients—of SAT scores (SAT), years of high school science (QI), years of high school math (QII), whether or not a course was an advanced placement course (QIII), the weighted sum of students' attitudes towards SMET courses (Q_SUM), team attitude (TEAMATTIT), number of hours of study per week (Q1_30 or HRS_STUD), the estimate of positive attitude (POSATTIT) and the estimate of negative attitude (NEGATTIT) towards SMET courses to be all statistically insignificant at the 95 percent level of confidence. Both the t-statistic and the F-statistic were insignificant at this level. This result means that there is no relationship in the specified model

between the above explanatory variables and white students' performance (GPA). In other words, there is no evidence of a relationship from the survey data as applied to the model in this study. The students' performance (GPA) may be influenced by other factors that are not captured by the survey.

The regression analysis for the Fall '97 data set involved six explanatory variables: SAT scores (SAT), years of high school science (QI), years of high school math (QII), whether or not a course was an advanced placement course (QIII), the weighted estimate of students' attitudes towards SMET courses (Q_SUM), and number of hours of study per week (Q1_30 or HRS_STUD). There was no information on team attitude (TEAMATTIT), positive attitude (POSATTIT), and negative attitude (NEGATTIT) in the Fall '97 data set.

The Fall '97 data for white students yielded results that are very similar to the results for the Fall '96 data. But whereas in the Fall '96 data, the coefficients of all the explanatory variables were insignificant. In the Fall '97 data, the coefficient of one of the explanatory variables (whether or not a course was an advanced placement course, QIII) was found to be statistically significant. The t-statistic and the F-statistic were significant at the 95 percent level of confidence or the 5 percent level of significance.

According to the regression result for the Fall '97 data, a one-unit change in QIII would cause a 33 percent improvement in white students' performance (GPA). However, the size of the coefficient of multiple determination (R^2) greatly undermines this result. The R^2 is only 0.05, which means that only 5 percent of the variation in white students' performance (GPA) is explained by the explanatory variables in the regression model. The performance of the students may be affected by factors that were not captured by the survey.

Like the results of the analyses for Fall '96 and Fall '97, the result of the analysis for Spring '98 did not provide any evidence for a significant relationship between the performance of white students and the explanatory variables in the regression analysis. Only the coefficient of SAT was found to be statistically significant. However, the actual magnitude of SAT was negligible. Even though the t-statistic and the F-statistic were significant at the 95 percent level of confidence, the R^2 was only 0.21—i.e., only 21 percent of the variation in white students' performance (GPA) can be explained by the explanatory variables in the Spring '98 data.

2. African Americans. The analysis of the Fall '96 data for African Americans showed the coefficients of years of high school science (QI), whether or not a course was an advanced placement course (QIII), and number of hours of study per week (Q1_30 or HRS_STUD) to be statistically significant at the 95 percent level of confidence, but the coefficients of all the other independent variables in the model were insignificant. The F-statistic was significant and the t-statistic was significant for QI, QIII, and HRS_STUD. According to the regression result, QI and HRS_STUD have inverse relationship with African American students' performance (GPA). That is, as QI or HRS_STUD increases GPA, tends to fall and, as QI or HRS_STUD decreases, GPA tends to rise for African Americans. In particular, the regression result indicates that an extra unit increase in the number of years of high school science will decrease GPA by about 11 percent and an extra unit increase in the number of hours of study will decrease GPA by about 13 percent for African American students.

On the other hand, the African American students' attitude towards SMET courses (Q_SUM) was found to vary directly with GPA. That is, as Q_SUM improves, GPA also improves. Specifically, a one-unit improvement in Q_SUM would improve the African American students' performance (GPA) by more than 67 percent. With an R^2 of 0.82, these results are quite robust. The R^2 of 0.82 means that 82 percent of the variation in African American students' performance (GPA) are explained by the variation in the explanatory variables in the regression model.

The sample size of African Americans participating in reformed courses in Fall '96 was only about eight students. This was not large enough to warrant a separate regression analysis for this category.

Unlike the Fall '96 data on African Americans that indicated relatively high statistical significance and explanatory power for the independent variables (especially QI, QIII, and HRS_STUD), the Fall '97 data on African Americans showed no statistical significance for the independent variables in the model. The R^2 in the Fall '97 analysis was only 0.19 compared to 0.82 in the Fall '97 analysis for African Americans. The coefficients of the independent variables in the reformed course subcategory were also statistically insignificant and the R^2 was only 0.11. The F-statistic and the t-statistic were both insignificant at the 95 percent level of confidence.

In the Spring '98 data set only six African American students were fully registered for courses covered by the survey and only one student participated in a reformed course. This number of students was considered to be too small to warrant a regression analysis. Hence, no regression analysis was conducted for this group in the Spring '98 data set. Instead, the analysis was conducted for the "Others" category, which included African Americans and all other nonwhite ethnic groups represented in the survey data.

3. All Others. This group includes all other nonwhite ethnic groups in the survey data (excluding African Americans for Fall '96 and Fall '97). The analysis of the Fall '96 data for this group showed that, for both the regular and reformed SMET courses, all the independent variables in the regression model are statistically insignificant. Both the F-statistic and the t-statistic were insignificant at the 95 percent level of confidence. This means that variations in the performance (GPA) of students in this category are not explained by the independent variables stipulated in the model. The variations may be due to factors not captured in the given data.

Like the Fall '96 data, the regression analysis on the Fall '97 data showed the coefficients of all the independent variables in the model to be statistically insignificant for both the regular and reformed SMET course categories. The F-statistic and the t-statistic were both statistically insignificant at the 95 percent level of confidence.

In Spring '98 the number of fully registered African American students (about six) was too small to be grouped into a separate category for regression analysis. Hence, the "All Others" category was enlarged to include African Americans. The Spring '98 regression results showed that a one-unit change in "whether or not a course was an advanced placement course" (QIII) would lead to a 91.5 percent improvement in the performance (GPA) of students in the "Others" category. The other five explanatory variables in the regression model

(SAT scores, number of years of high school science, number of years of high school math, the weighted estimate of students' attitude towards SMET courses, and the number of hours of study per week) all had statistically insignificant coefficients. The t-statistic was significant at the 95 percent level of confidence and the R^2 was about 0.45, meaning that about 45 percent of the variation in the performance (GPA) of students in this group can be explained by the explanatory variables in the current model.

Analysis by Gender

1. Males. The regression analysis of the Fall '96 data for males showed no significant association between the performance (GPA) of male students and the stipulated explanatory variables in the regression model.

Unlike the Fall '96 data, which yielded statistically insignificant coefficients for all the explanatory variables, the Fall '97 data for males yielded statistically significant coefficients for two of the explanatory variables in the regression model. The coefficients, of both the number of hours of study per week (Q1_30 or HRS_STUD) and whether or not a course was an advanced placement course (QIII), were found to be statistically significant at the 95 percent level of confidence. The coefficients indicate that, for a one-unit change in QIII, male students' performance (GPA) would improve by about 39 percent and, for a one-unit change in HRS_STUD, the students' performance would improve by about 4 percent.

The results of the Spring '98 regression analysis are somewhat similar to the results of the Fall '96 analysis for males. The Spring '98 analysis yielded statistically insignificant coefficients for all the explanatory variables except SAT scores. The coefficient of SAT is statistically significant, but its magnitude is insignificant. The F-statistic and the t-statistic are both significant at the 95 percent level of confidence, but the R^2 is only 0.19. Hence much weight cannot be given to the significance of the coefficient of SAT in the Spring '98 analysis for males. The performance (GPA) of the male students may, perhaps, be more strongly influenced by factors that are not accounted for in the given survey data.

2. Females. Like the data for males, only the Fall '97 data yielded statistically significant results in the regression analysis for females. Both the Fall '96 data and the Spring '98 data yielded statistically insignificant results in the regression analysis for females.

The Fall '97 data, however, produced statistically significant coefficients for SAT scores (SAT), years of high school math (QII), and whether or not a course was an advanced placement course (QIII). The magnitude of the SAT coefficient was negligible, but QII and QIII had coefficients of 0.27 and 0.25, respectively. This means that, for a one-unit increase in QII, female students' performance (GPA) would improve by 27 percent and, for a one-unit change in QIII, the students' performance would improve by 25 percent. Both the t-statistic and the F-statistic were significant at the 95 percent level of confidence.

Analysis by Age Category

There are two age categories: students who are nineteen years old or younger (Age≤19) and students who are twenty years old or older (Age≥20).

1. Age≤19. For this age category, the analysis of the Fall '96 data showed that the only variable with a positive effect on the students' performance (GPA) was whether or not a

course was an advanced placement course (QIII). All the other explanatory variables had coefficients that were either statistically insignificant or negligible in magnitude. The F-statistic was significant and the t-statistic was significant for SAT scores and for QIII at the 95 percent level of confidence. However, the magnitude of the SAT coefficient was negligible.

The regression result shows that a one-unit change in QIII would cause the performance (GPA) of students in the age category Age<=19 to improve by more than 20 percent. However, the explanatory power of the independent variables was quite weak, with an R^2 of only about 0.07. This means that only about 7 percent of the variation in the performance (GPA) of the students in the age category Age<=19 may be explained by variations in the independent variables in the model. The performance of the students may be affected by factors that are not captured in the current survey data.

Like the Fall '96 data, the Fall '97 data for the age category Age<=19 showed SAT scores and whether or not a course was an advanced placement course (QIII) to have statistically significant coefficients. In addition, the coefficient of number of years of high school math (QII) was also significant at the 95 percent level of confidence. Like in the Fall '96 analysis, the magnitude of the SAT coefficient was negligible, but QII and QIII had coefficients of 0.29 and 0.33, respectively. This result means that a one-unit increase in QII would improve the performance (GPA) of students in the age category Age<=19 by about 29 percent. Similarly, a one-unit change in QIII would lead to a 33 percent improvement in the students' performance.

In the Spring '98 analysis, the same set of variables was found to be statistically significant as in the Fall '97 analysis. Like the Fall '97 data, the Spring '98 data showed SAT scores (SAT), number of years of high school math (QII), and whether or not a course was an advanced placement course (QIII) to have statistically significant effects on the performance of students in the age category Age<=19. The magnitude of the coefficient of SAT was negligible like in the Fall '96 and Fall '97 analyses. However, the coefficients of QII and QIII indicate that a one-unit increase in QII would improve the performance (GPA) of the students in this age category by as much as 86 percent and a unit change in QIII would lead to a 44 percent improvement in the students' performance. The F-statistic and the t-statistic were both highly significant at the 95 percent level of confidence.

2. Age≥20. For this age category, none of the explanatory variables in the regression model had a positive effect on the performance of the students. The Fall '96 data, the Fall '97 data, as well as the Spring '98 data for the age category Age>=20 yielded statistically insignificant results for all the explanatory variables in the regression model. This means that, for the students in this age category, performance (GPA) level cannot be explained by the explanatory variables stipulated in the regression model.

Grade Analysis

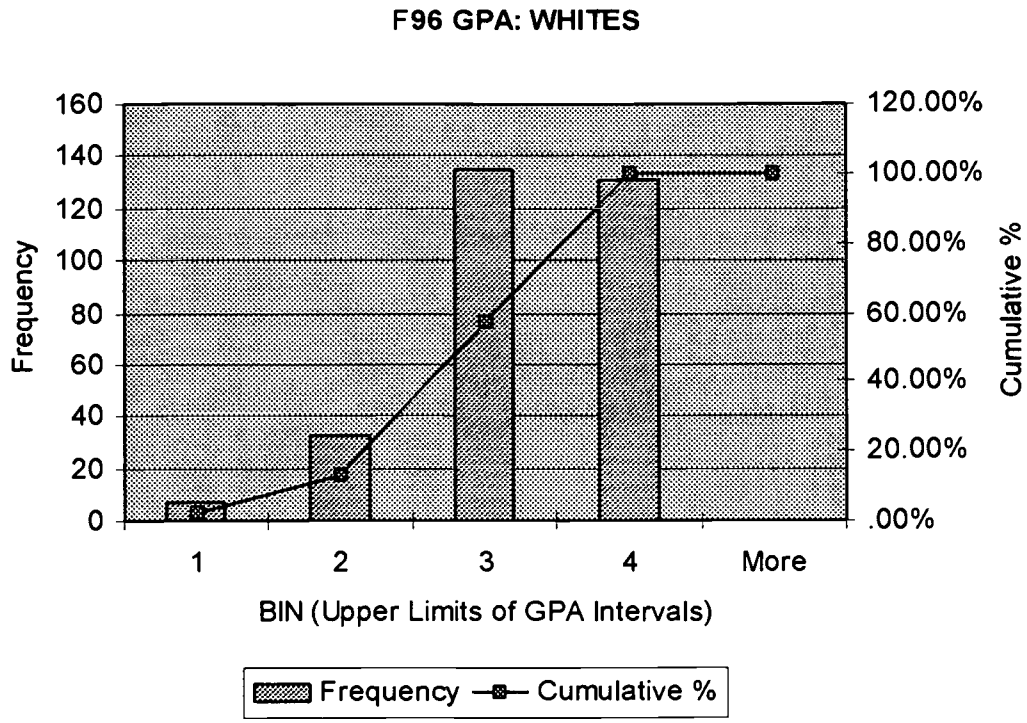
The grade analysis was conducted by ethnic group, by sex, and by the age categories Age<=19 and Age>=20. The analysis covered only those students who were fully registered for SMET courses and participated in the SMET course survey. For all the different data categories, the results of the grade analysis were similar for both the reformed courses and

the regular courses. In other words, the grade analysis did not provide any strong evidence for differences between the reformed courses and the regular courses with regard to students' attitude and performance in SMET courses. Hence, only the results for the regular courses are stated here, but they can be interpreted similarly for the reformed courses.

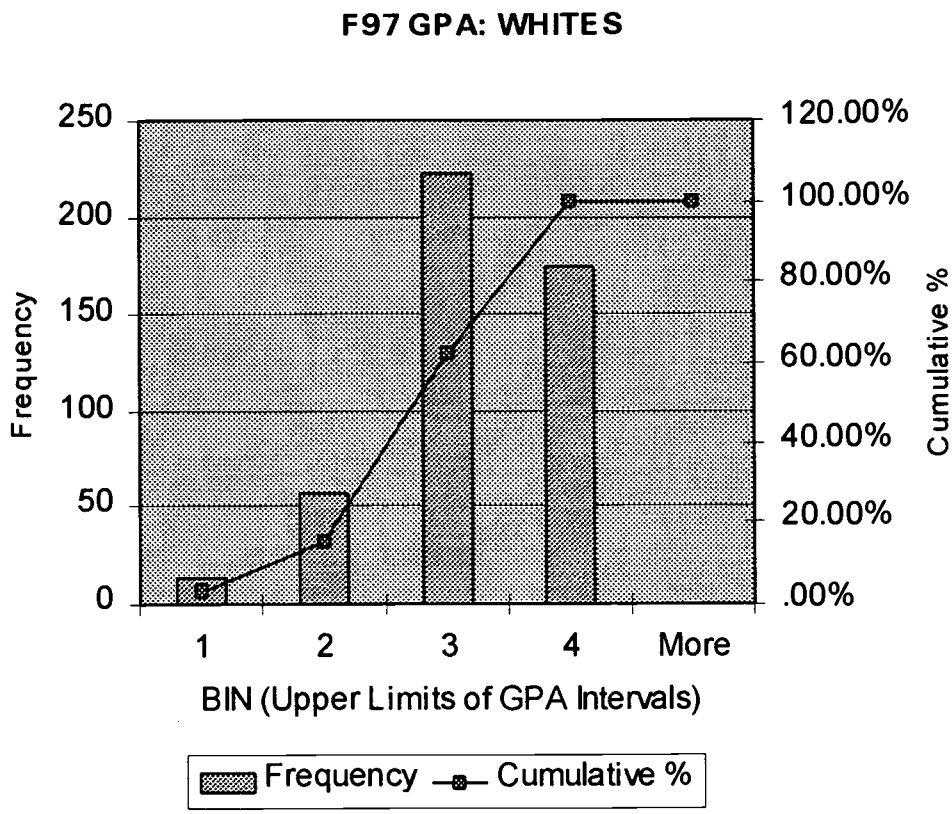
Analysis by Ethnic Group

The ethnic groups include Whites (Caucasians), African Americans, and "All Others."

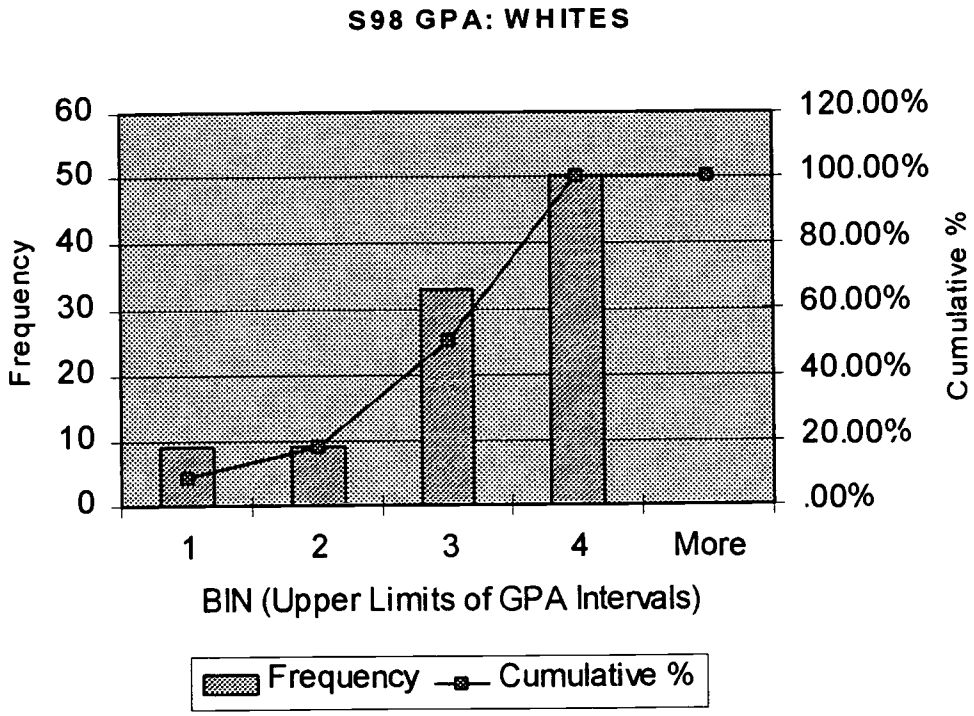
1. Whites. In Fall '96, about 2.3 percent of the white students who participated in SMET courses obtained grades that were less than D^+ and 43 percent obtained grades higher than a B.



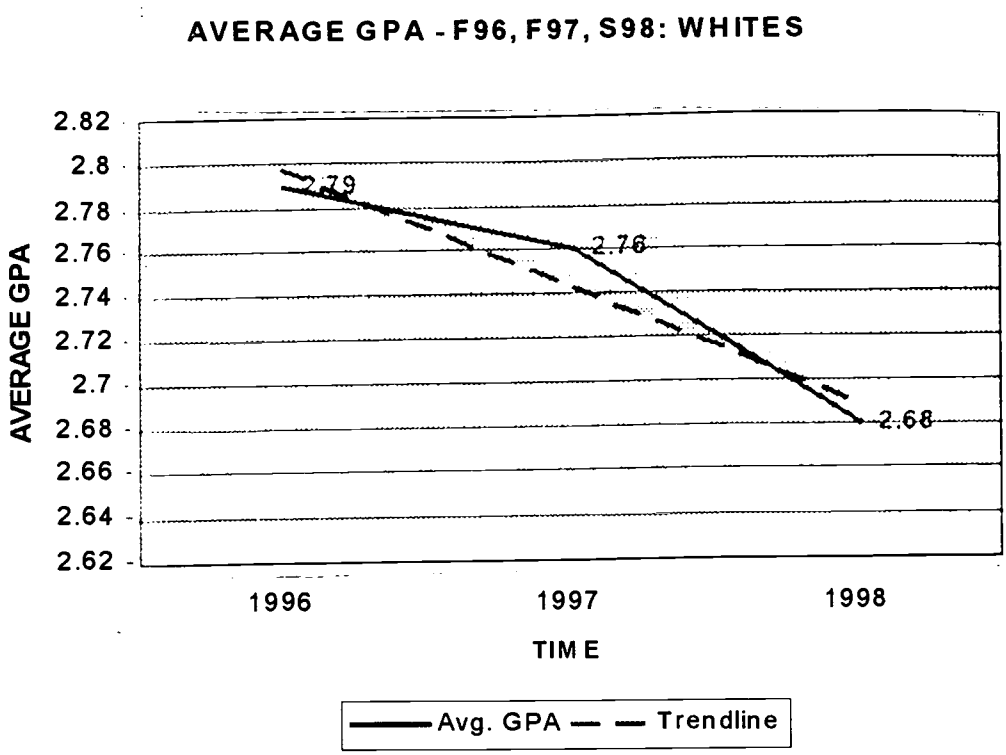
The percentage of white students with grades less than D+ in Fall '97 was slightly higher, at 3 percent, than in Fall '96 and the percentage of students with grades higher than B in SMET courses declined to 37 percent in Fall ' 97 from 43 percent in Fall '96.



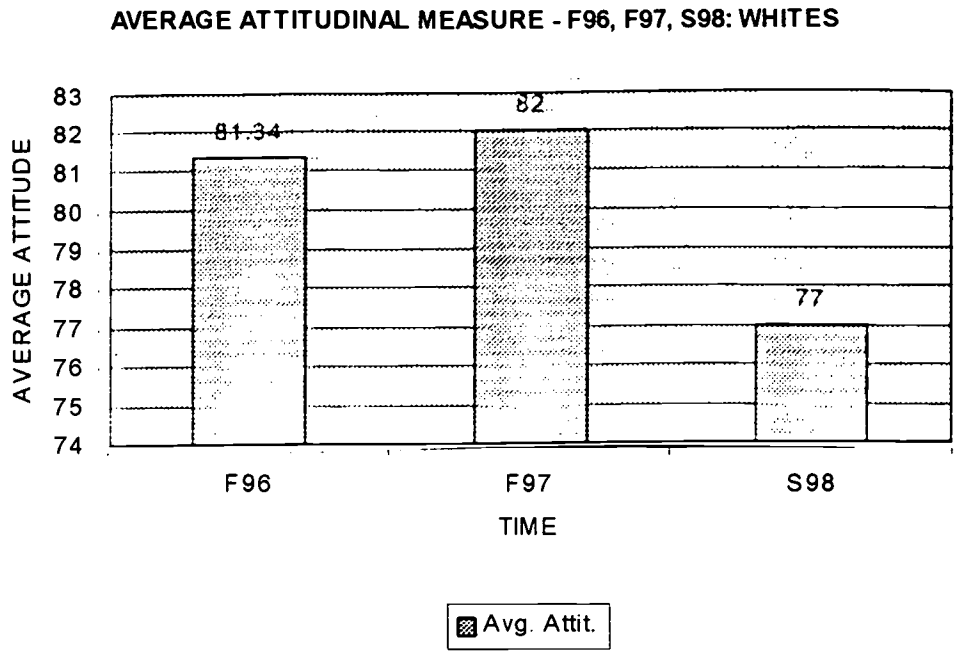
In Spring '98, both the percentage of students with low grades and the percentage of those with high grades increased significantly. But the increase in the percentage of those with high grades was larger. About 9 percent of the students obtained grades less than a D^+ and nearly 50 percent obtained grades higher than B.



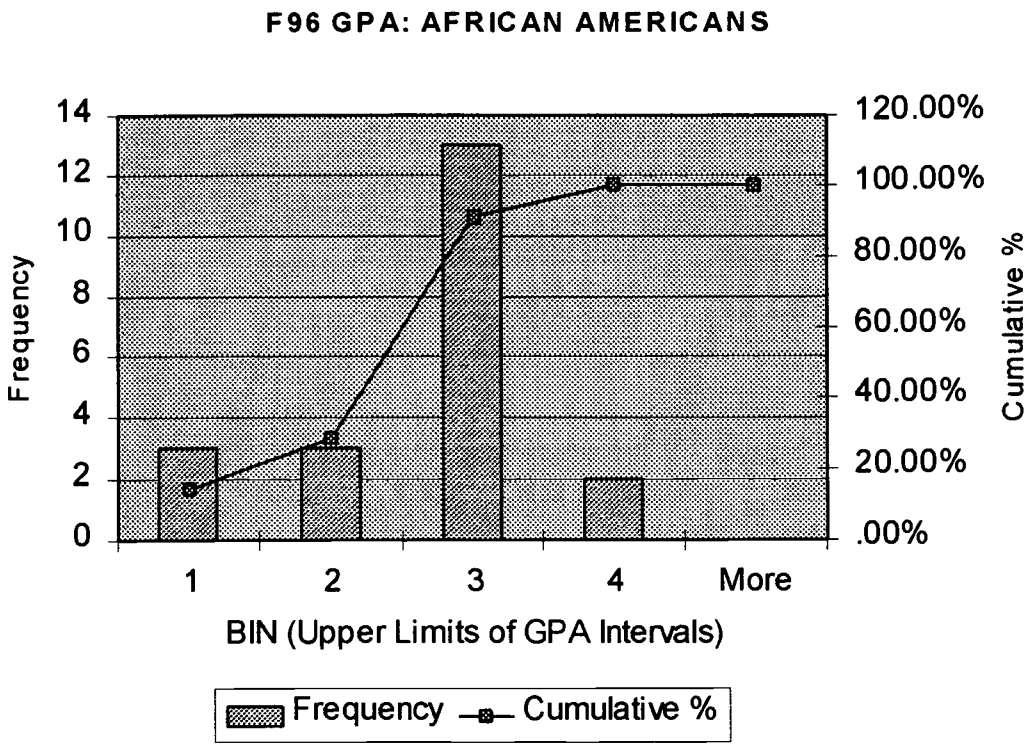
The average GPA for white students remained almost unchanged at about 2.8 between Fall '96 and Fall '97, but it fell to about 2.7 in Spring '98.



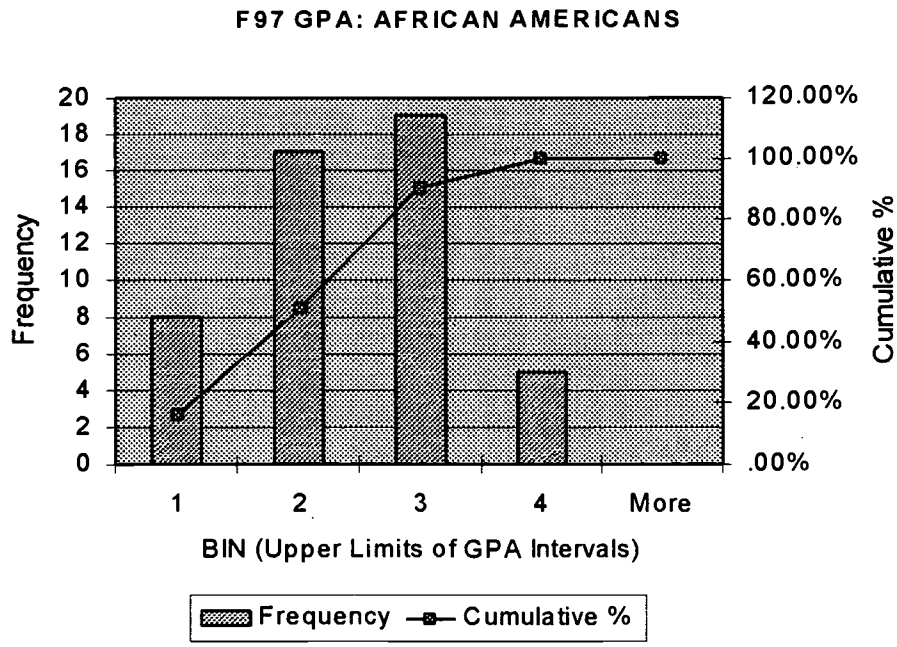
There was very little change in white students' attitude toward SMET courses between Fall '96 and Fall '97. However, in Spring '98 there was a 6-percent improvement in the students' attitude towards SMET courses.



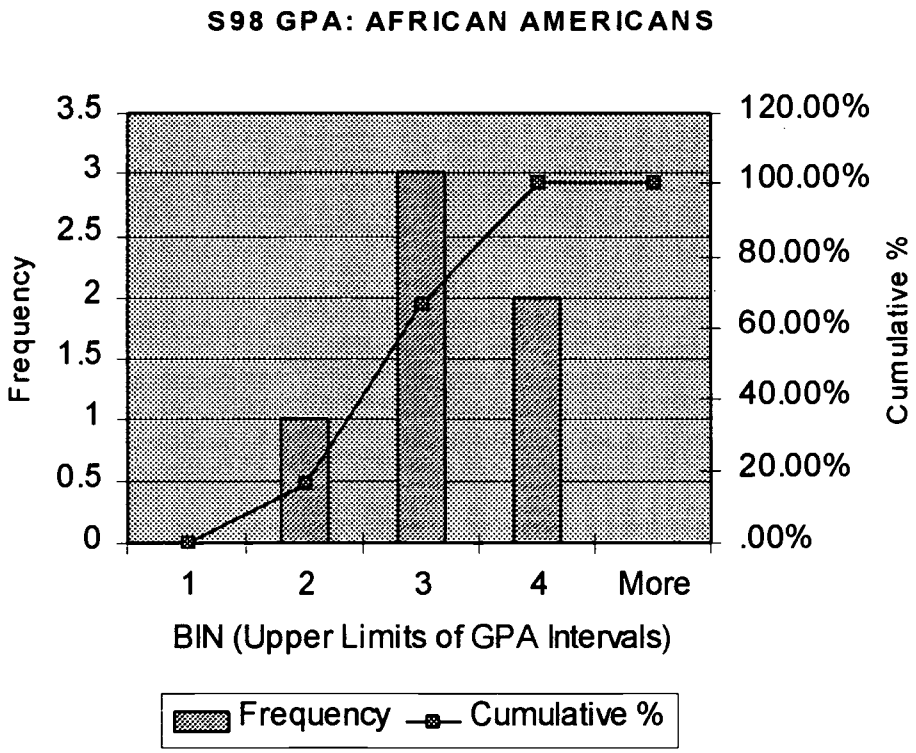
2. African Americans. In Fall '96, about 14.3 percent of African American Students obtained grades less than D and only 9.5 percent obtained grades higher than B.



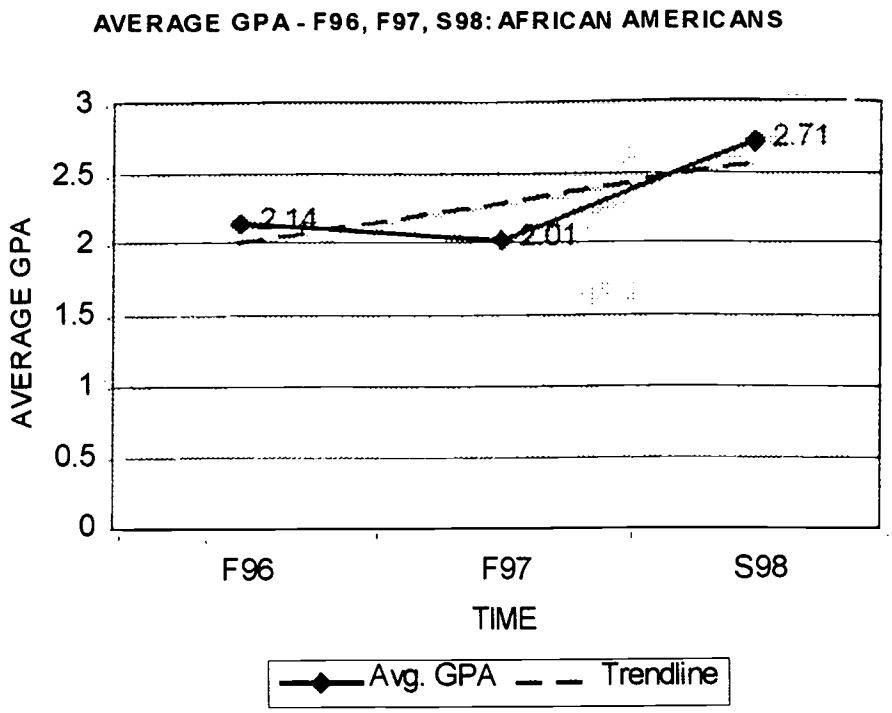
In Fall '97, the percentage of African Americans with grades less than D^+ increased by 2 percentage points to 16.3 percent from 14.3 percent in Fall '96. But the percentage of students with grades higher than B increased by less than one percentage point to 10.2 percent in Fall '97 from 9.5 percent in Fall '96.



The grade performance of African Americans appeared to have improved significantly in Spring '98. Roughly zero percent of African American students obtained grades less than D^+ and over 33 percent obtained grades higher than B.

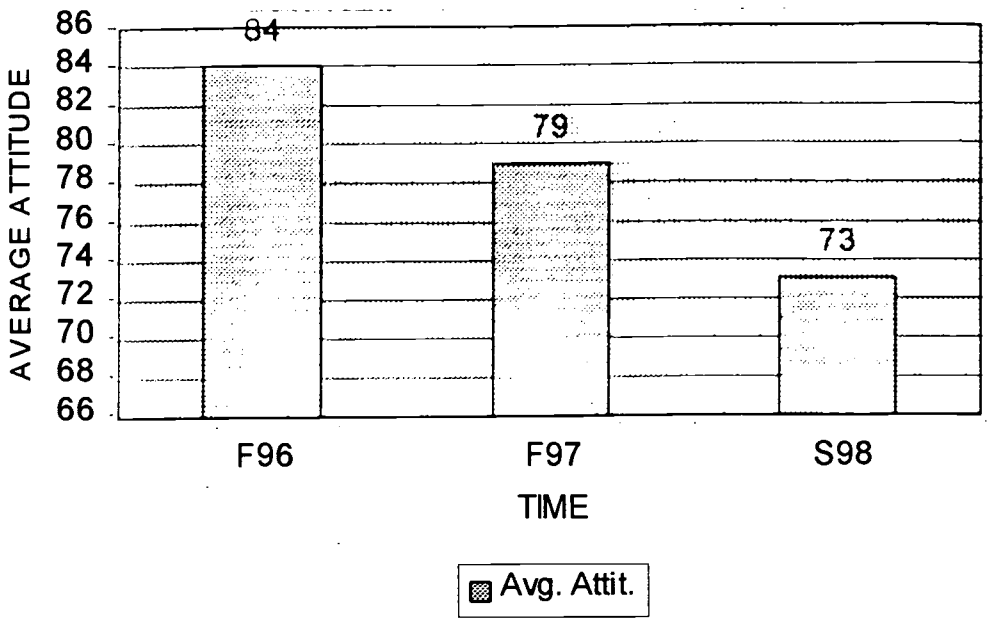


The average GPA for African Americans was around 2.0 in both Fall '96 and Fall '97 but it approached 3.0 in Spring '98.

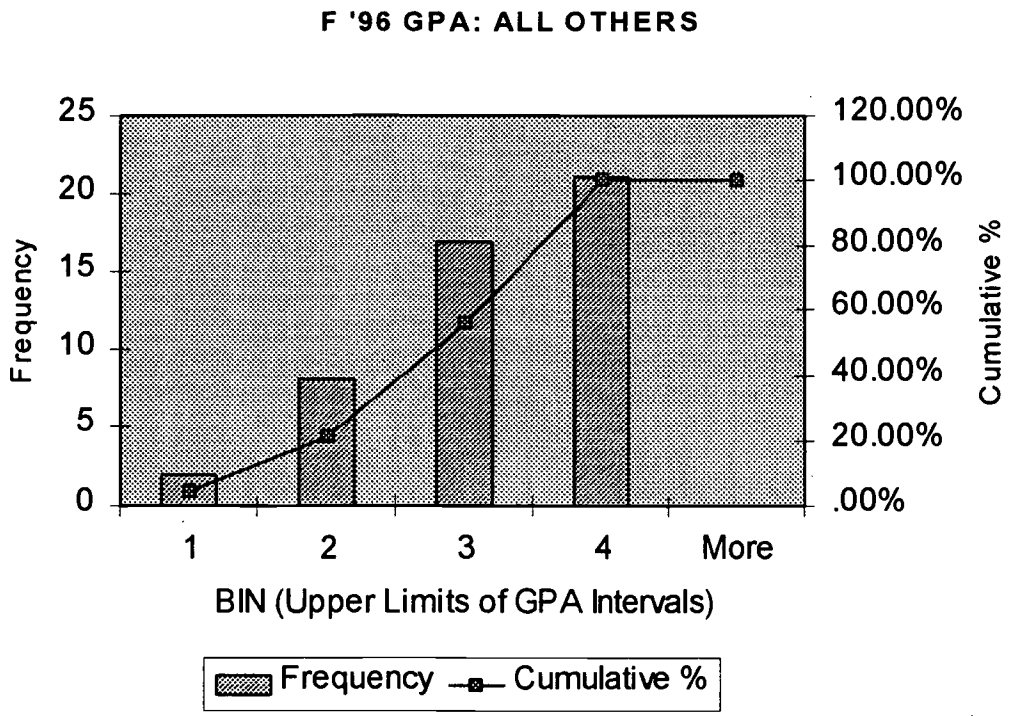


The attitude of African American students towards SMET courses improved by about 6 percent in both Fall '97 and Spring '98 from the Fall '96 and Fall '97 levels, respectively.

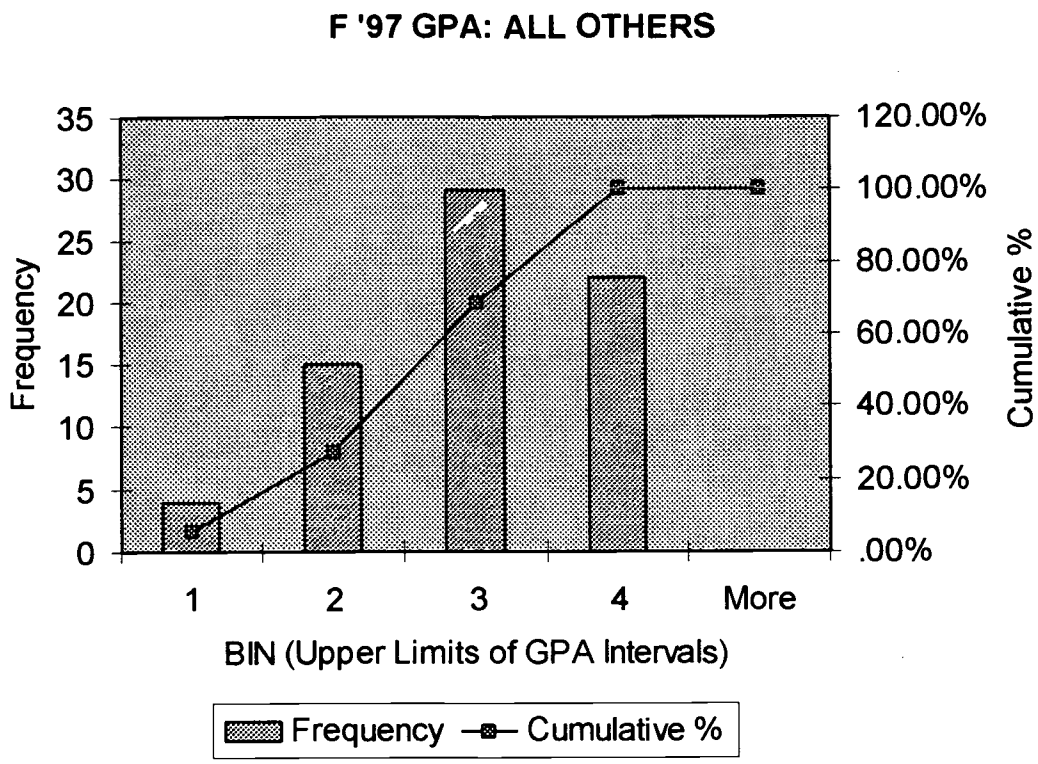
AVERAGE ATTITUDINAL MEASURE - F96, F97, S98: AFRICAN AMERICANS



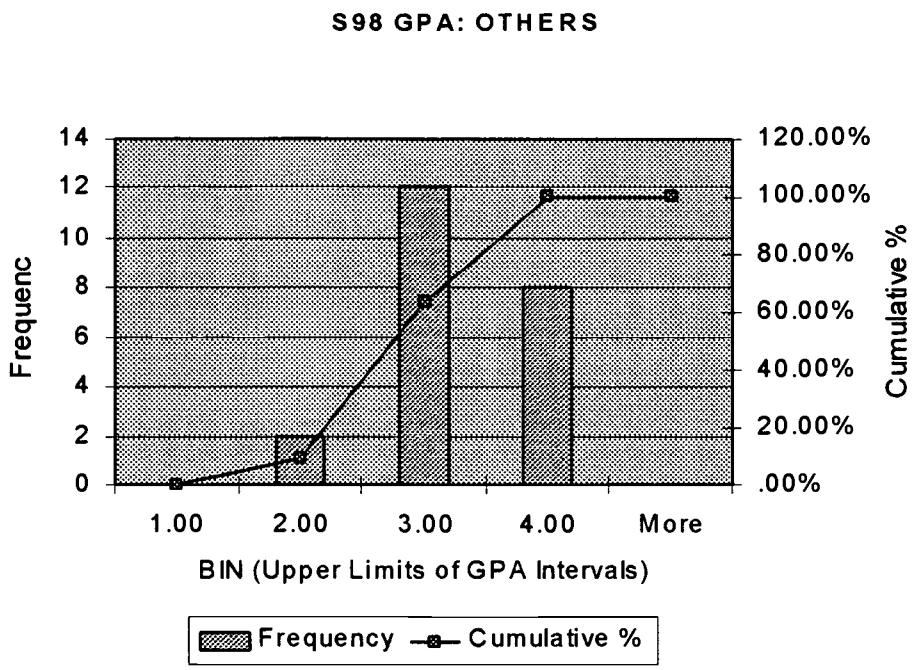
3. All Others. In Fall 96, about 4.2 of the students in the "All Others" category obtained grades less than D+ and roughly 44 percent obtained grades higher than B in SMET courses.



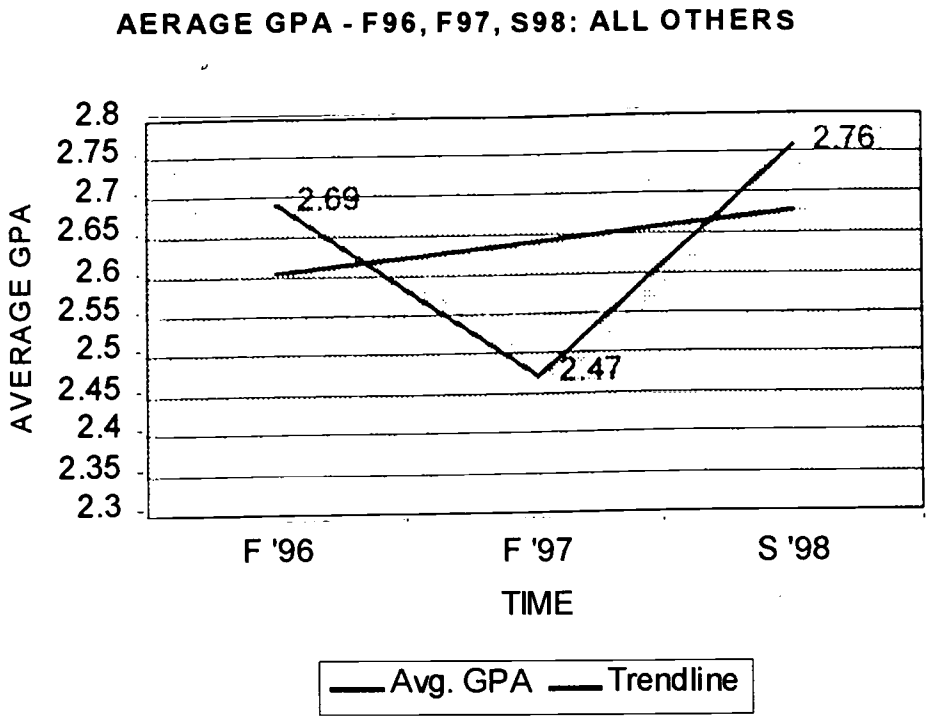
In Fall '97, the grade performance of students in the "All Others" category was slightly worse than in Fall '96. About 5.7 percent of the students obtained grades less than D^+ and 31.4 percent obtained grades higher than B in Fall '96, compared to 4.2 percent and 44 percent respectively in Fall '97.



The performance in Spring '98 was much better for the "All Others" category; zero percent of the students obtained grades less than D+ and about 36 percent obtained grades higher than B in SMET courses. It should be noted, however, that the Spring '98 data for this category included African Americans because the population of the latter group was too small to form a separate category for analysis.

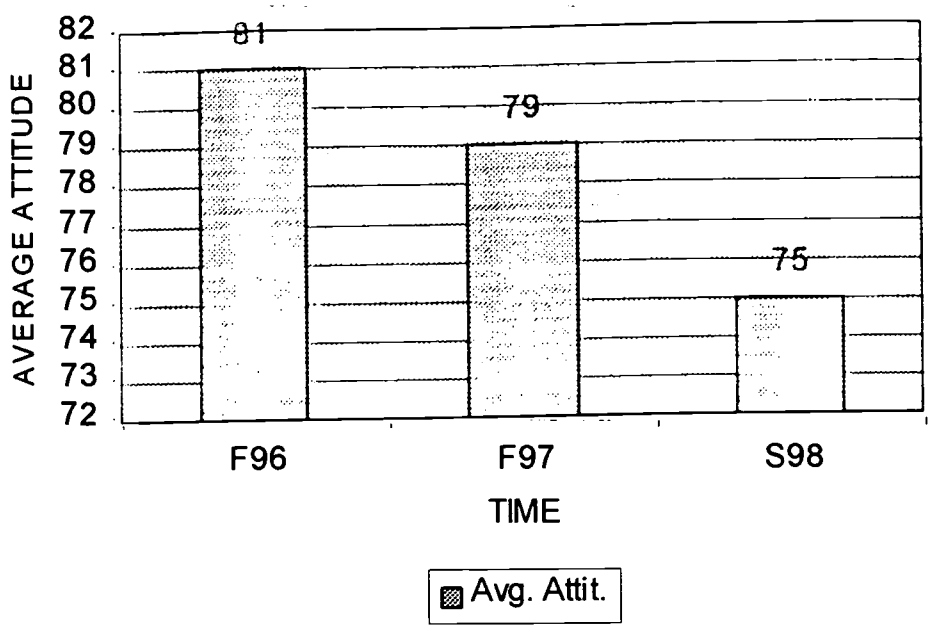


The average GPA for students in the "All Others" category fell from about 2.7 in Fall '96 to about 2.5 in Fall '97, but it increased to about 2.8 in Spring '98.



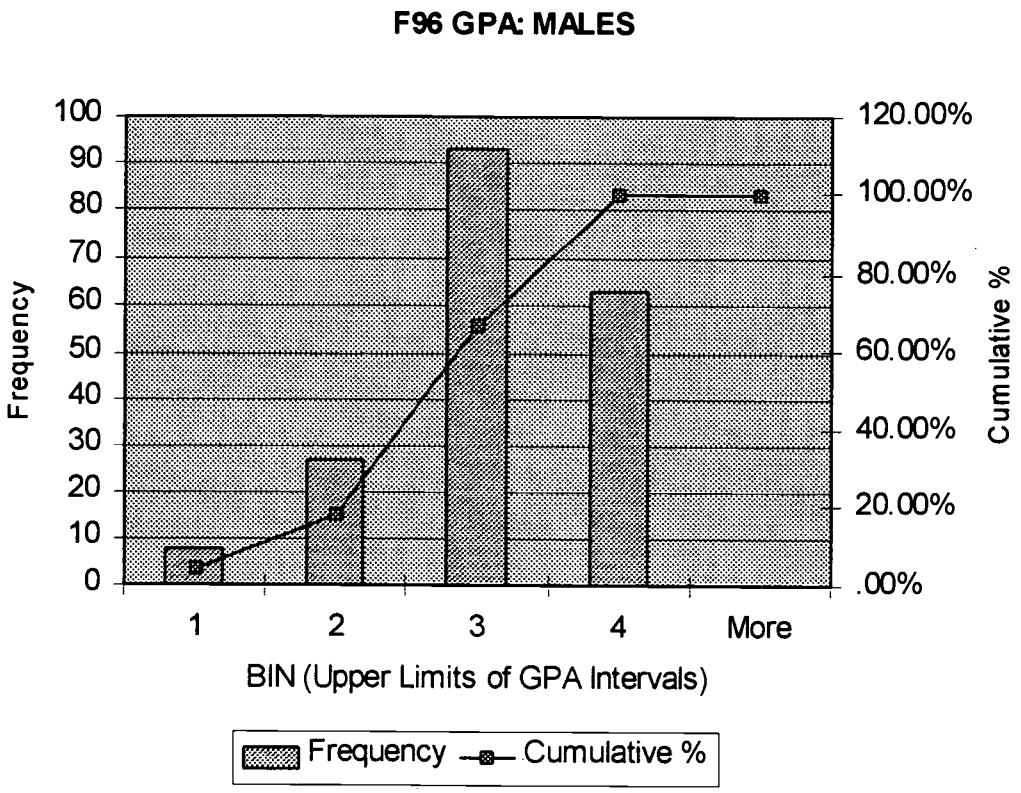
The attitude of the students towards SMET courses was virtually unchanged between Fall '96 and Fall '97 but there was a 5-percent improvement in Spring '98.

AVERAGE ATTITUDINAL MEASURE - F96, F97, S98: ALL OTHERS

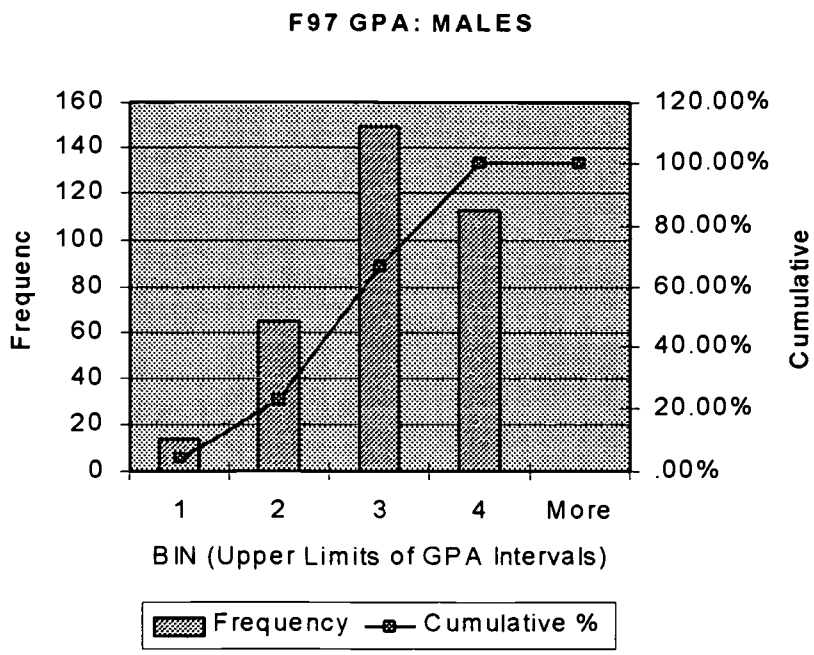


Analysis by Gender

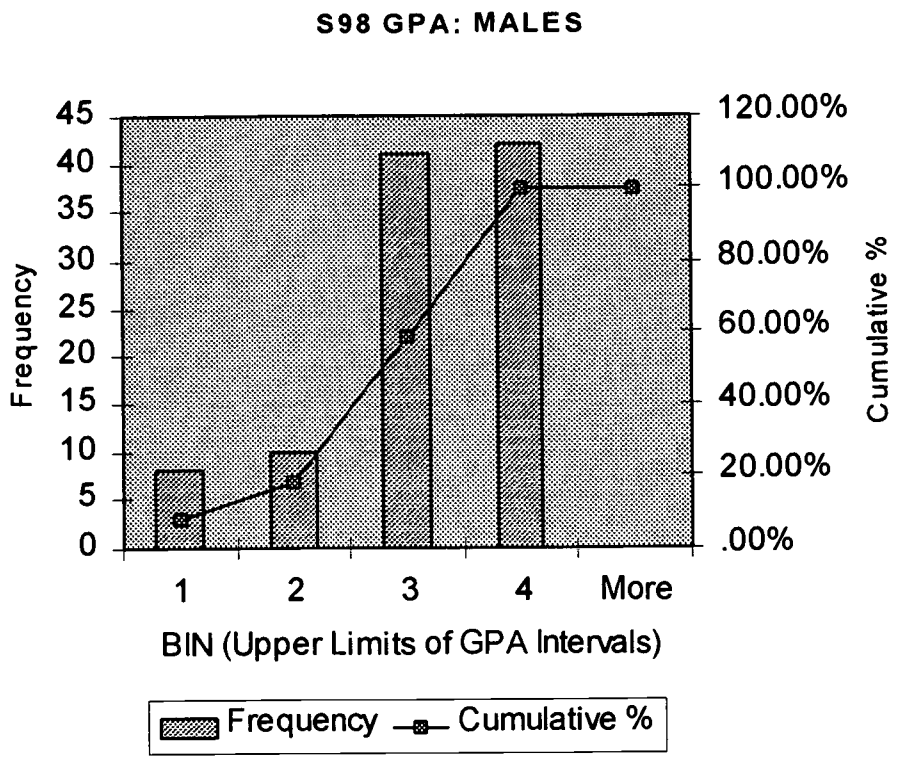
1. Males. In Fall '96, about 4.2 percent of male students obtained grades less than D+ in SMET courses and 33 percent obtained grades higher than B.



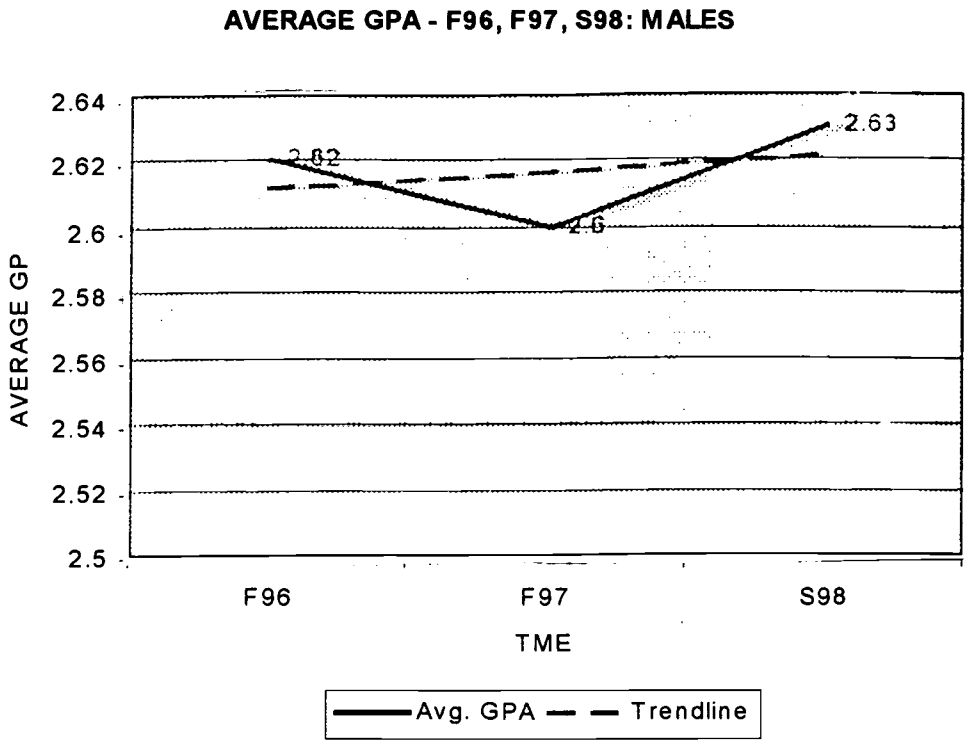
In Fall '97, the grade performance of male students was virtually unchanged form the Fall '96 level, with about 4.1 percent of the students with grades less than D+ and 33.2 percent with grades higher than B.



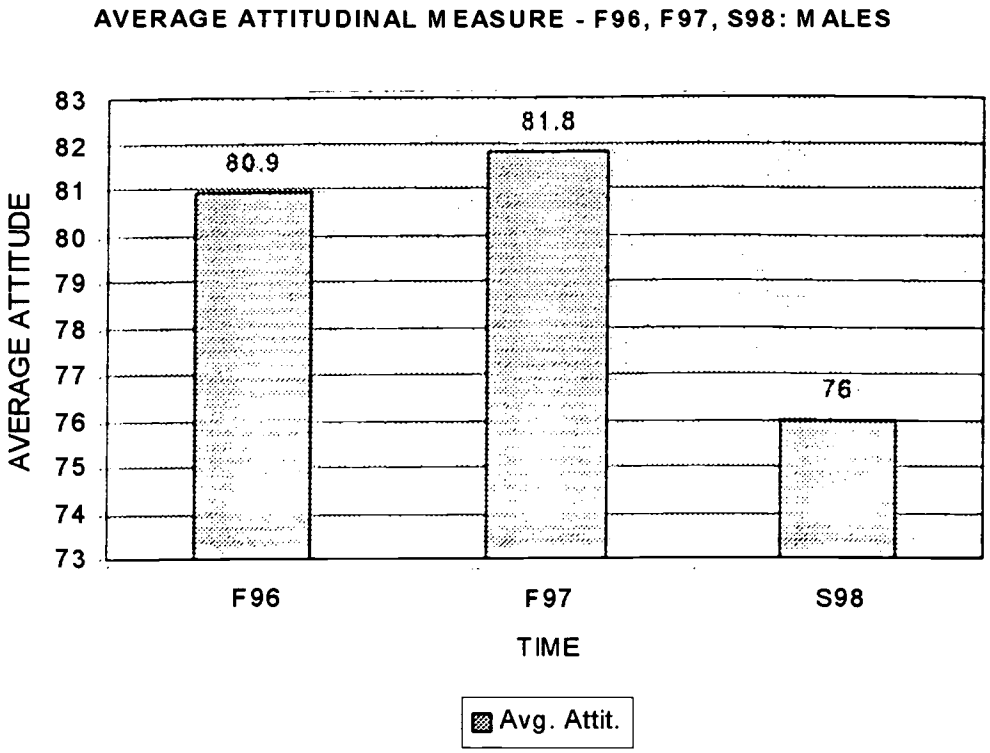
In Spring '98, the percentage of male students with grades less than D+ doubled to 8 percent form the Fall '97 level and the percentage of students with grades higher than B increased to 42 percent from 33.2 percent in Fall '97.



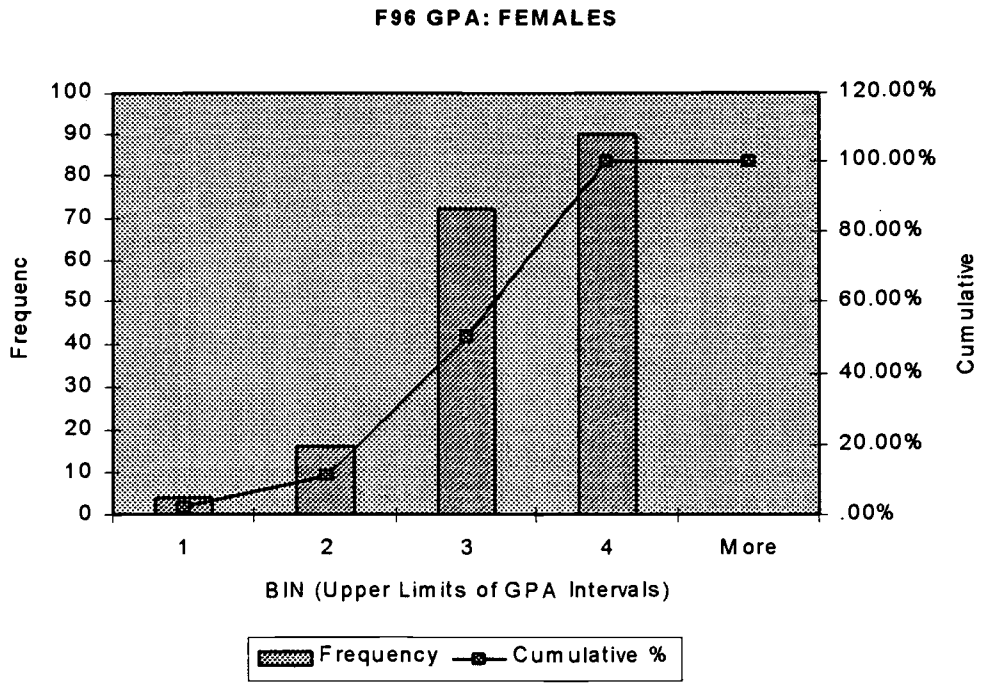
The average GPA for males hovered around 2.6 in Fall '96, Fall '97, and Spring '98.



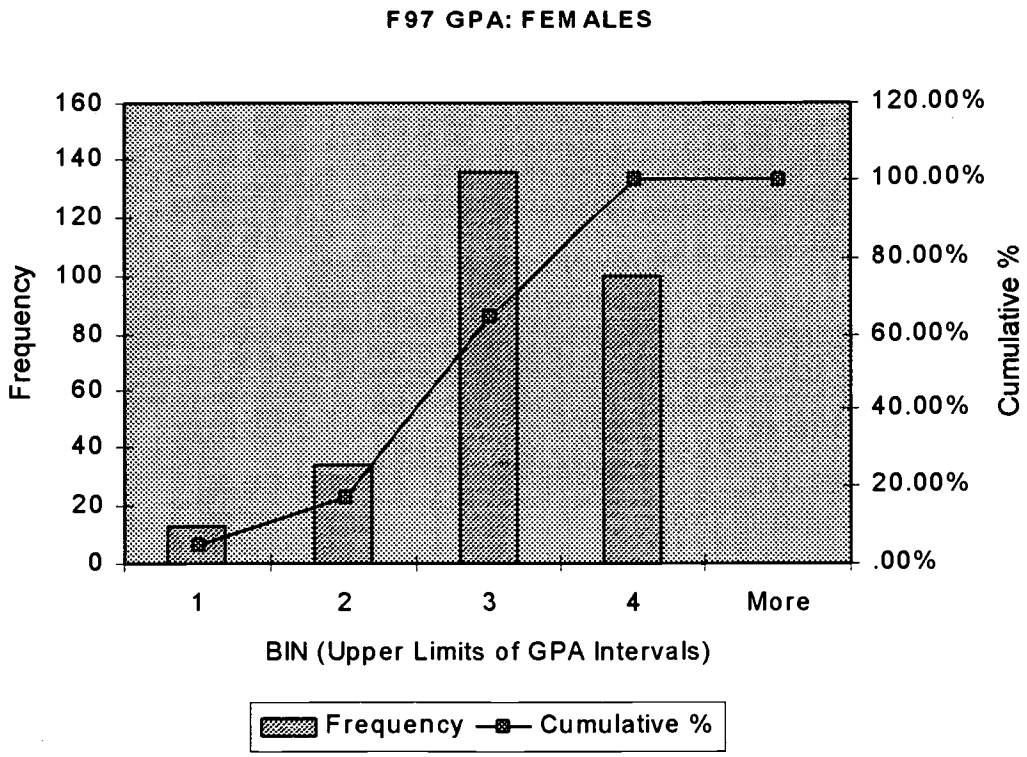
There was no significant improvement in the students' attitude towards SMET courses between Fall '96 and Fall '97, but there was a 7 percent improvement in Spring '98.



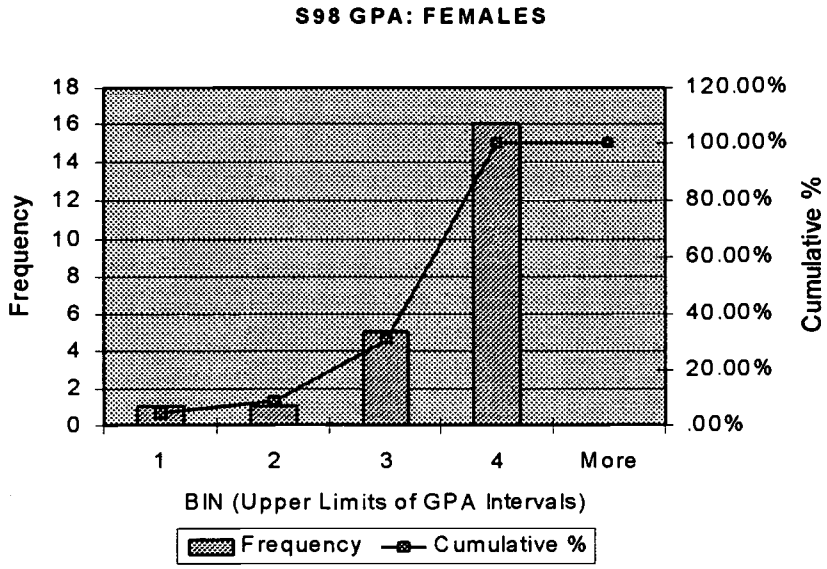
2. Females. In Fall '96, only 2.2 percent of female students obtained grades less than D+ and almost 50 percent obtained grades higher than B in SMET courses. This performance was significantly better than that of males in the same period.



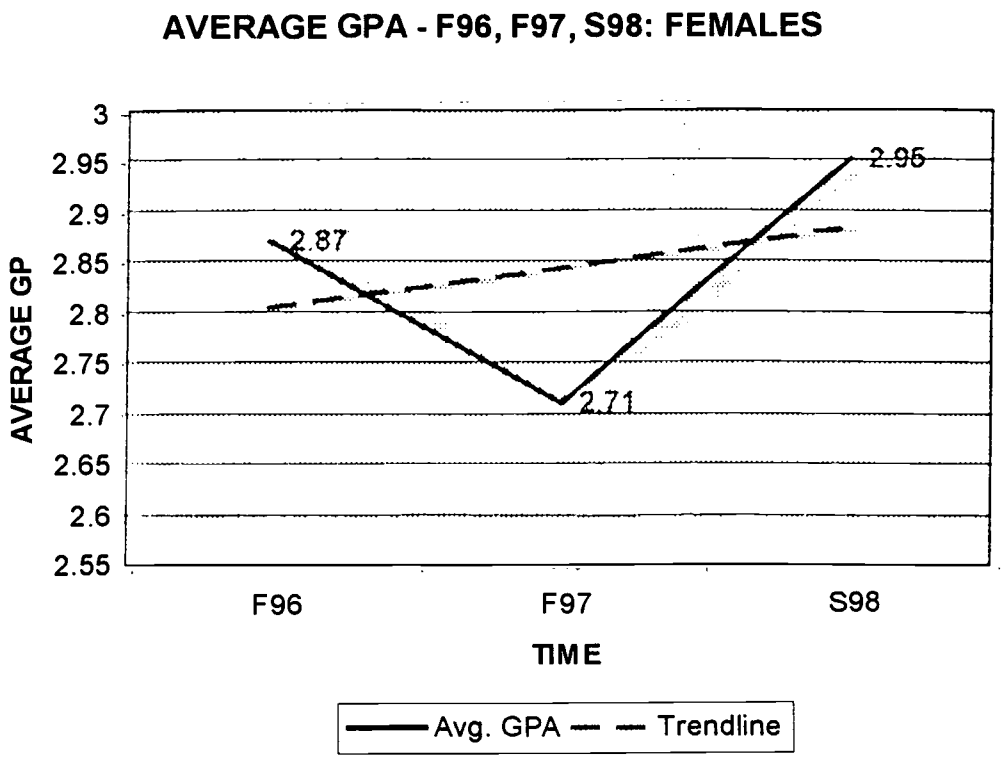
Compared to their performance in Fall '96, the grade performance of females worsened quite a bit in Fall '97. About 4.6 percent of the female students obtained grades less than D+ compared to 2.2 percent in Fall '96. Roughly 36 percent obtained grades higher than B but this figure is about 14 percentage points lower than the Fall '96 figure.



In Spring '98, the grade performance of females improved significantly. The performance of males improved also, but the improvement in the performance of females was much greater than that of males. The performance of females improved by almost 100 percent form the Fall '97 level. Only about 4.4 percent of female students obtained grades less than D+ in Spring '98 and almost 70 percent had grades higher than B, compared to about 36 percent in Fall '97.

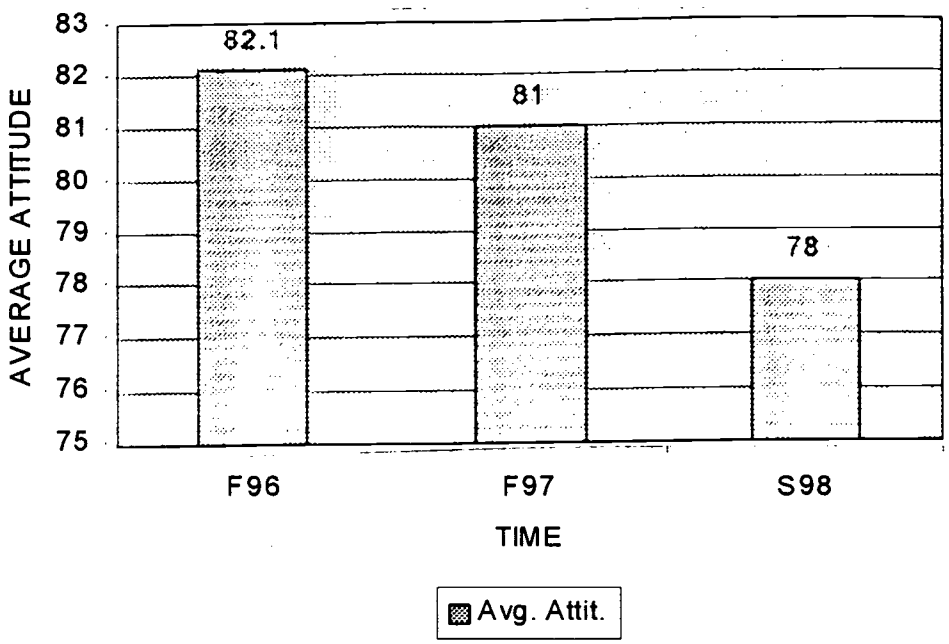


The average GPA for females was about 2.9 in Fall '96. It dropped to 2.7 in Fall '97 but rose again to about 3.0 in Spring '98. For males the average GPA hovered around 2.6 in all three periods (Fall '96, Fall '97, and Spring '98).



Like the male students' attitude, the female students' attitude towards SMET courses showed no significant change between Fall '96 and Fall '97. In Spring '98, however, female students' attitude showed a slight improvement.

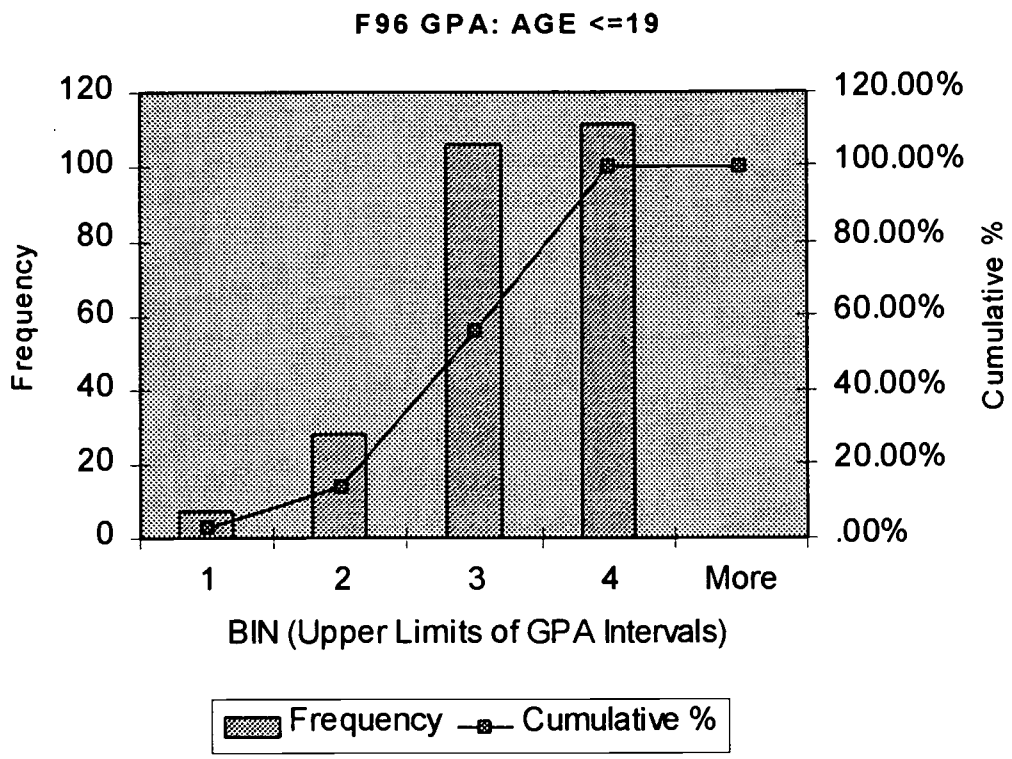
AVERAGE ATTITUDINAL MEASURE - F96, F97, S98: FEMALES



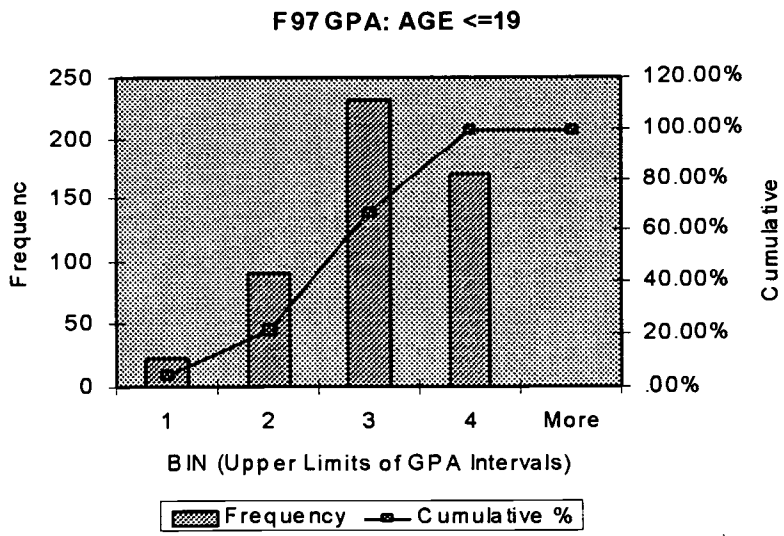
Analysis by Age Category

Two age categories were designated: students whose age is less than or equal to nineteen (Age<=19) and students whose age is greater than or equal to twenty (Age>=20).

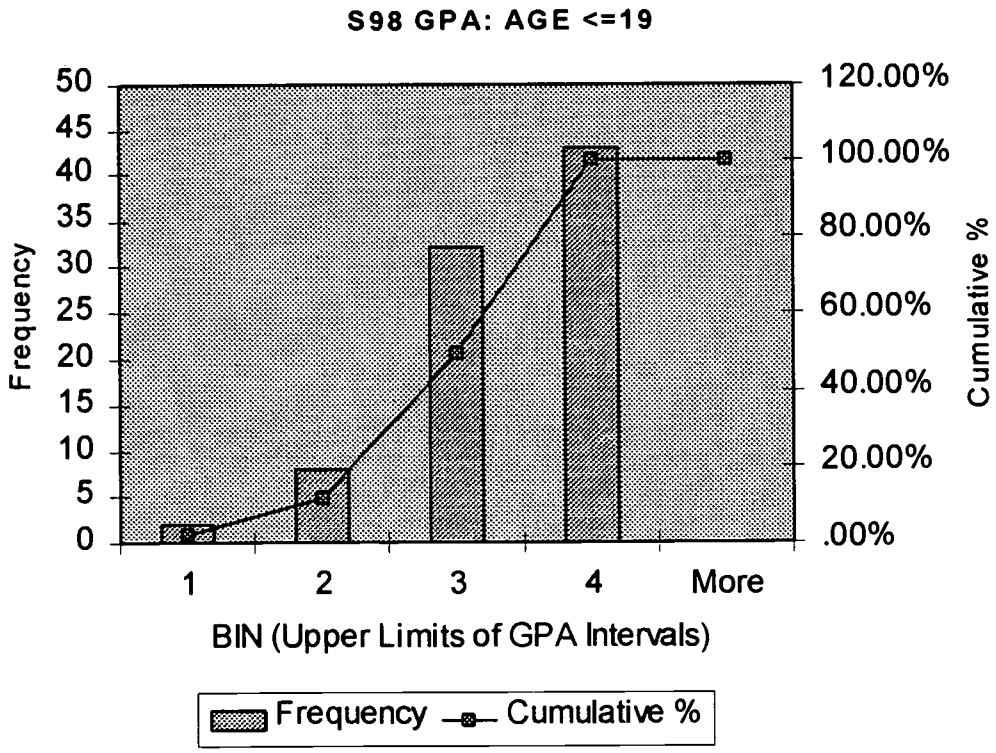
1. Age≤19. In Fall 96, about 2.8 percent of the students in the category Age≤19 obtained grades less than D+ and about 44 percent obtained grades greater than B.



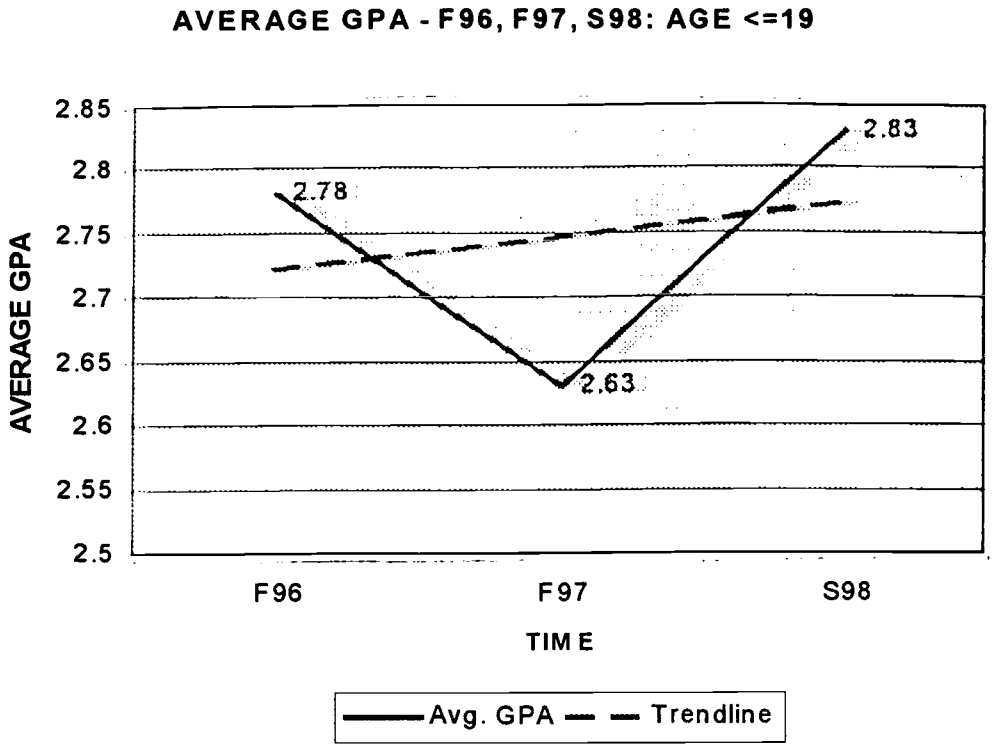
In Fall '97, the grade performance of students in the age category Age<=19 declined slightly. About 4.3 percent of students had grades less than D+ compared to 2.8 percent in Fall '96 and 31 percent had grades higher than B compared to 44 percent in Fall '96.



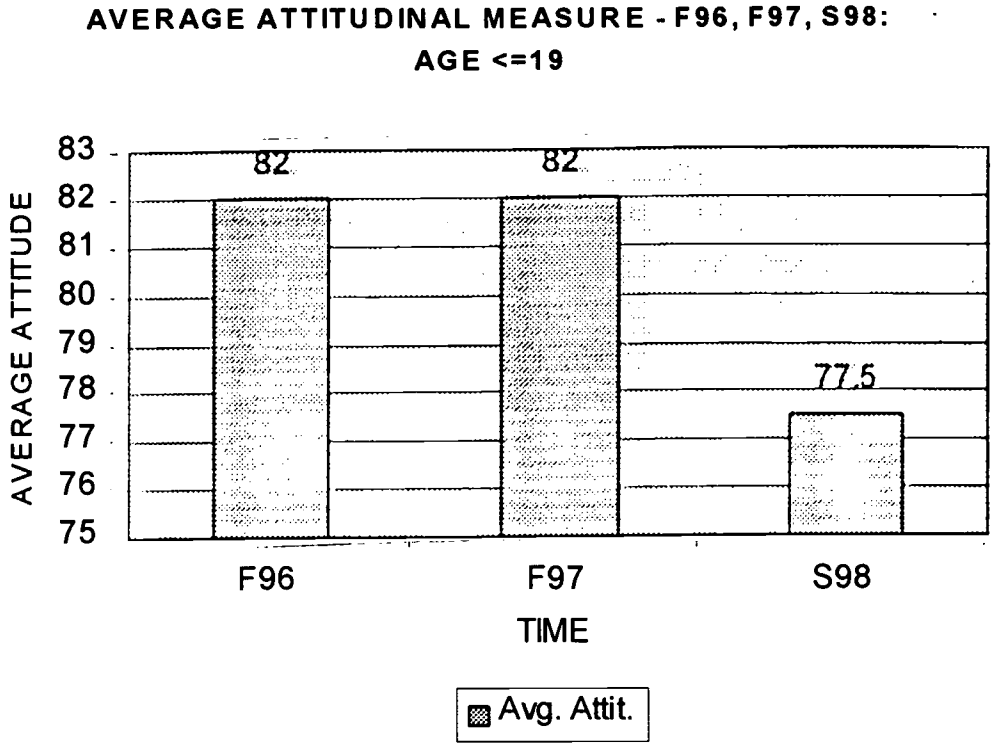
In Spring '98, students in the age category Age<=19 showed significant improvement in their grade performance. Only 2.4 percent of the students in this category had grades less than D^+ and over 50 percent had grades higher than B.



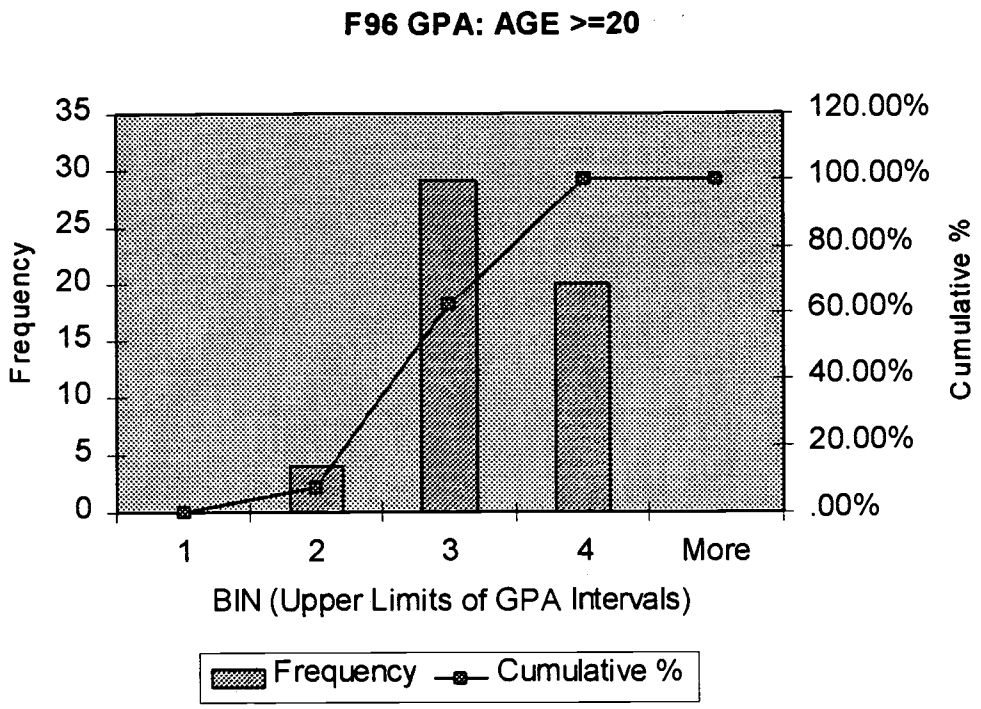
The average GPA for students in the age category Age<=19 was about 2.8 in Fall '96, about 2.6 in Fall '97, and about 2.8 in Spring '98.



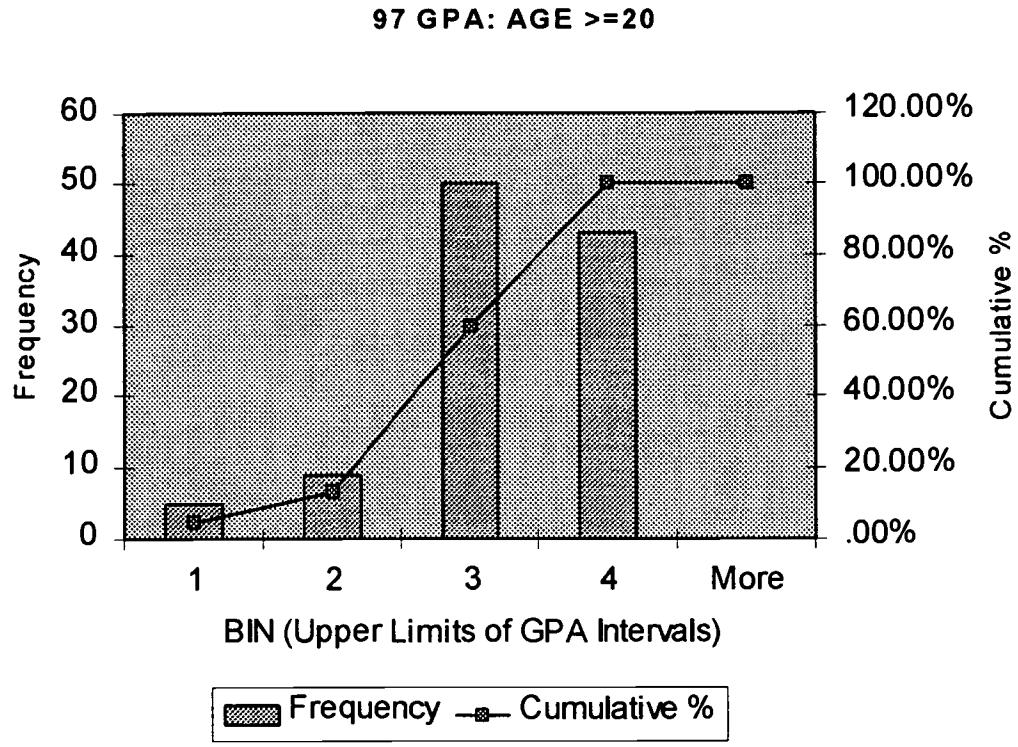
The attitudinal measure for this age category Age<=19 showed that the attitudes of students towards SMET courses did not change between Fall '96 and Fall '97. In Spring '98, however, there was a 5 percent improvement in the students' attitude towards SMET courses.



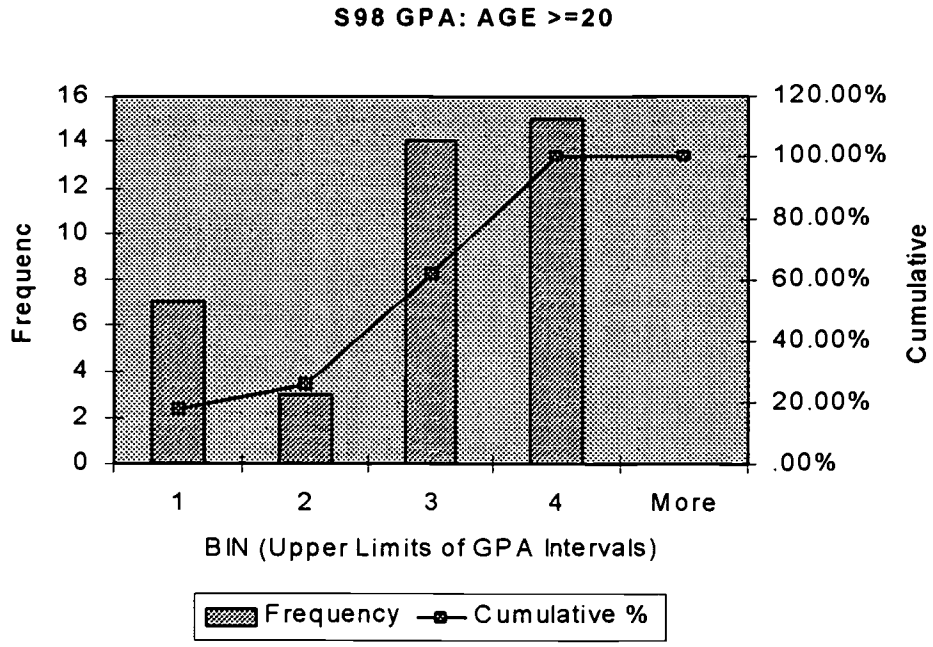
2. Age≥20. In Fall '96, none of the students in the age category Age>=20 obtained a grade less than D+ in SMET courses, but roughly 38 percent obtained grades higher than B.



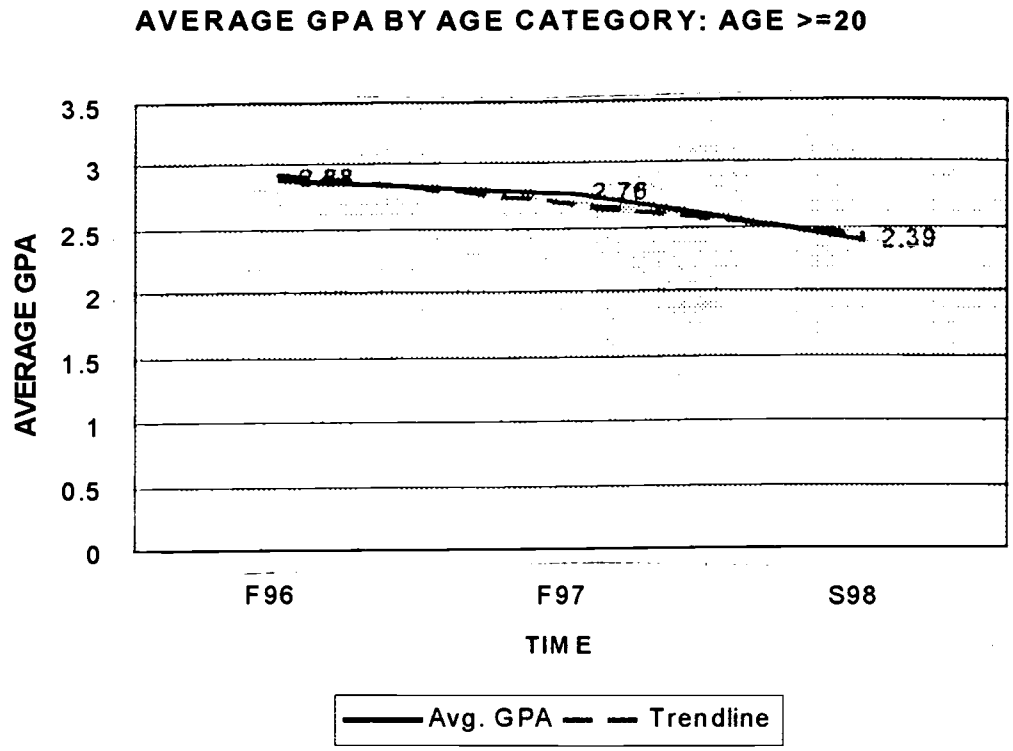
In Fall '97, more of the students in the age category Age>=20 had grades less than D+, but more of the students also had grades higher than B in SMET courses. About 4.7 percent of the students had grades less than D+ compared to zero percent in Fall '96; about 40.2 percent had grades higher than B compared to 37.7 percent in Fall '96.



In Spring '98 the performance of students in this age category declined quite a bit. The percentage of students with grades less than D+ more than tripled to about 18 percent in Spring '98 from 4.7 percent in Fall '97. The percentage of students with grades higher than B also declined slightly to 38.5 percent from 40.2 percent in Spring '98.

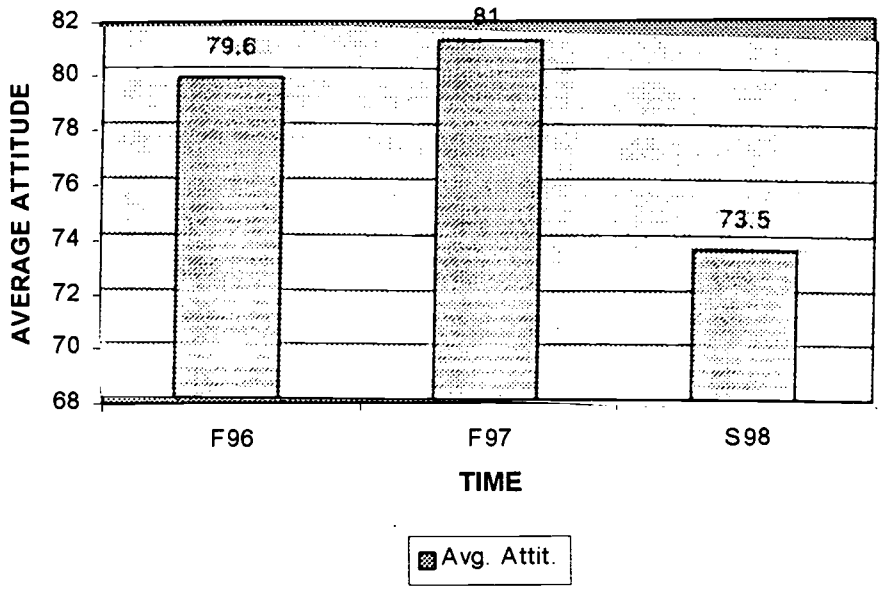


For this age category, the average GPA was around 3.0 in Fall '96 and Fall '97 but it fell to 2.4 in Spring '98.



Like the age category Age<=19, the age category Age>=20 did not show much improvement in attitude towards SMET courses between Fall '96 and Fall '97. But in Spring '98 there was a 9 percent improvement in the students' attitude towards SMET courses.

AVERAGE ATTITUDINAL MEASURE - F96, F97, S98: AGE >=20



Summary

Regression analyses were conducted to determine the effect of certain stipulated factors on the overall performance (GPA) of students in SMET courses. A grade analysis was also conducted to investigate possible patterns in the grade performance of students in different ethnic, gender, and age categories. The analytical technique involved mainly multiple regression analysis and the use of simple statistical tools such as histograms and line graphs.

In all of the different categories there was no significant difference between the reformed and the regular courses with regard to students' attitudes and performance in SMET courses. In other words, students' performance and/or attitudes did not appear to be better or worse in reformed courses than in regular SMET courses. More time may be needed for the reform process to produce the desired results.

In the regression analysis, no significant relationship was found between white students' performance (GPA) and the stipulated independent variables in the model. Only the SAT score was suspect for some influence on the students' performance.

For African Americans the most significant result was obtained from the Fall '96 data that showed the students' attitude towards SMET courses to have the most significant positive effect on their performance. A one-unit improvement in the students' attitude towards SMET courses was found to improve their performance by as much as 67 percent.

In both the Fall '96 and Fall '97 data for the "All Others" category, no statistical evidence was found for a relationship between the performance of students in this category and the given explanatory variables in the model. But the regression analysis on the Spring '98 data showed that, whether or not a course was an advanced placement course, (QIII) had a highly significant effect on the performance of students in this category. A unit change in QIII was found to cause nearly a 92 percent improvement in the performance of students in the "All Others" category. It must be noted, however, that African Americans were included in the Spring '98 data for "All Others" because the African American population was not large enough to form a separate category for analysis.

In the regression analysis by gender only, the Fall '97 data yielded statistically significant results for both males and females. For males, number of hours of study (HRS_STUD) and whether or not a course was an advanced placement course (QIII) were the factors found to have positive effects on the students' performance.

Whether or not a course was an advanced placement course (QIII) was also found to be significant for females. But instead of number of hours of study per week found to be significant for males, number of years of high school math (QII) was the additional significant factor for females.

The regression analysis by age category showed significant results only for students in the age category Age<=19. For this age category, whether or not a course was an advanced placement course, (QIII) was found to influence students' performance in the Fall '96 data. In addition to QIII, the Fall '97 data and Spring '98 data also showed SAT score and years of High School math to influence the performance of students in this category. The effect of SAT scores, however, was negligible.

For the age category Age>=20, the regression analysis showed that there was no relationship between the performance of the students and the given explanatory variables in the model.

The grade analysis showed some differences in performance between the different ethnic categories. There was some fluctuation in the performance of white students, but there was no dramatic gain in performance by this category.

African Americans showed some gains in performance but, overall, their grade performance was worse than the other two categories—whites and "All Others."

Grade performance worsened slightly for the "All Others" category in Fall '97, but the group showed some improvement in Spring '98.

In the gender categories, the grade analysis showed that the performance of females was significantly better than their male counterparts. The grade performance of females in SMET courses was found to be better than males in Fall '96, Fall '97, and Spring '98.

In the age categories, there was not much of a difference in grade performance between the two age categories Age<=19 and Age>=20 in the Fall '96 data and Fall '97 data. The Spring '98 data, however, showed that grade performance in the age category Age>=20 declined significantly while the age category Age<=19 posted substantial gains in Spring '98.

Clearly, it was difficult to identify a consistent pattern in the results of both the regression and grade analyses. Furthermore, some of the results were rather perverse. Part of the problem might be with the data generation process and the manner in which certain variables were measured. Hence, none of the results presented in this report is conclusive. Further research is definitely needed. It might be helpful to seek to identify other factors—not captured by the previous survey—that might influence students' performance in SMET courses. Nonetheless, the findings in the current study can be used to identify certain problem areas for improving students' performance and for improving the quality of future study.

Final Notes on Quantitative Analysis

It is stated in the report that there was no information on the variables "team attitude" (TEAMATTIT), "positive attitude" (POSATTIT), and "negative attitude" (NEGATTIT) in the 1997 and 1998 data sets and, therefore, those variables were not included in the correlation and regression analyses. This statement means that, while the aforementioned variables existed as clearly defined fields in the 1996 data set, they were not so defined in the 1997 and 1998 data sets. In fact, they did not exist as data fields. CRE was informed that those variables were created in the 1996 data set by grouping students' responses to certain questions on the survey. However, the same process was not followed for the 1997 and 1998 data sets. Therefore, it was concluded that there was no information on those variables.

CONCLUSION

On the basis of the analysis of quantitative and qualitative data, CRE concludes that the University of Hartford Institution-Wide Reform project has accomplished its objectives for this two-year initiative and, thus, is a success. Indeed, the list of accomplishments is extensive. Data indicates that this grant produced results that went well beyond the anticipated outcomes.

For example, the list of reformed courses exceeds the variety and number of courses identified in the original proposal. Student enrollment and retention in SMET courses is improving. Faculty and administration are highly supportive of the initiative. Additionally, the University has succeeded in obtaining several large grants that stem directly from and that continue the work begun by Institution-Wide Reform. The comprehensive list of accomplishments and related documentation include many other noteworthy results.

Despite these beneficial accomplishments, the analysis also shows that there remains a substantial amount of work that must be done to achieve the overall goals of restructuring this institution of higher education for the 21st century and establishing a national model for emulation. The disagreements between faculty and administrators regarding authority and responsibility are indicators that the work for institution-wide reform is ongoing.

Institutions resist change. Institutions consist of people, and people have routine behaviors—those behaviors are based on perceptions and attitudes. Institution-wide reform—systemic reform—depends on *substantive* change of a system's key elements and processes. In order for the institution to change, the people have to adopt new patterns of thinking and acting.

Thus, it is not surprising that the University of Hartford is not totally transformed in only two years. Indeed, the list of new grants received by the institution indicates that there is both the foresight and the capacity to take the next important steps toward systemic reform.

In CRE's opinion, the main concern for the University's immediate future is the gritty and sensitive task of redefining the roles and expectations for the university professors and administrators to support innovative management, effective leadership, and creative teaching.

In order to create a university system that is substantively different from—and more effective, in these times, than—the model of higher education that has been in existence in this country since 1870[3], the University needs to scale up the changes in its daily work schedule, its work routines, its rewards and recognition, its authority structure, and its organizational structure.

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[3]Hoyt, John W. *Address on University Progress* . New York: D. Appleton & Company, 1870. According to Hoyt, the earliest universities came into existence in the eleventh and early twelfth centuries. This particular address examines the institution's historical development until late in the 19th century and outlines justification and principles for establishing the nation's first research university at Johns Hopkins University.

Accordingly, twelve key objectives for the second phase in the University's systemic reform should be

- continuous use of process improvement strategies;
- goal-orientation;
- objective-based, long-term planning and short-term planning;
- need-based, professional development; and
- 100% capacity of those available "on board;"
- collaborative decision-making;
- teamwork;
- efficiency in all operations;
- flexible work schedules;
- positive workplace attitudes;
- accountability for results; and
- independent external evaluation.

These terms extend and refocus the Key Elements of Reform identified in May 1996 by the University's "Shaping the Future" organizational meeting.

Interview data indicates that the co-principal investigators and other key participants are fully aware of the challenge that lies ahead and are ready to continue the work.

Nonetheless, CRE strongly encourages the University to pursue these objectives more vigorously and more aggressively than it has done thus far. There should be a detailed, three to five year strategic plan outlining specific tasks and processes, accountable individuals and teams, measurable outcomes, formative and summative progress reports, and firm deadlines.

Institution-Wide Reform successfully initiated the process of systemic change at the University of Hartford. Now, the team should scale up to obtain the full commitment to reform by every individual, by every group, and at every level. In five years, there should not be a leaf unturned and the model should appear in full relief.

RECOMMENDATIONS

CRE provides the following specific recommendations for Institution-Wide Reform in order to help the University implement the next stage of systemic reform, with special attention to SMET disciplines. These recommendations are taken directly from the interview data for this evaluation study. Thus, they are relevant to this project.

- Increase commitment to the initiative at all levels.
- Recognize that innovation is a formative process and that innovators need a long-term commitment to realize success.
- Assemble the grant's principal players for a meeting to evaluate what worked and what did not work in order to determine what lessons were learned in the process. Then, determine what steps to take next. Reaffirm or establish a long-range plan for institutional reform.
- Increase internal and external communication about the project's activity, highlighting structural and policy changes and giving special emphasis to the implications for faculty, students, and administration. Key participants among administration and faculty need to be better informed about the larger picture.
- Establish tangible rewards for people who engage in institution-wide reform efforts.
- Require assessment of effects of the institution's main processes on targeted audiences and establish overall accountability for results.
- Provide workshops on systematic measurement of student outcomes and data-based decision-making for development of programs, curriculum, and courses.
- Provide regular opportunities for faculty and administrators to learn about teamwork and to enjoy the benefits of, and the rewards for, collaboration.
- Extend the initiative to courses at sophomore, junior, and senior levels; to additional programs; and ultimately, to the entire university. Push systemic reform to the highest levels in order for the full benefits of systemic reform to be realized.
- Provide funding and other resources to help continue the change process after the grant has ended—particularly for follow-up activity, technology, and equipment—so that the driving force remains strong.
- Include ongoing external evaluation of institution-wide reform.

These specific recommendations—taken mainly form study participants—parallel the general pattern of thinking today regarding the conditions for systemic reform. The content of this list indicates a high level of awareness, across the campus, of the requirements for systemic reform.

BIOGRAPHICAL SKETCHES

Curriculum Research and Evaluation is a firm that is devoted to research and development of programs in the field of education. CRE's specialities are: (1) to provide services in order to evaluate the quality of education programs for private business and industrial companies, public and private funding agencies, and schools; and (2) to develop and guide the implementation of curriculum and instruction.

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Theresa Bruckerhoff is Operations Manager and Research Associate for Curriculum Research and Evaluation. She has a B.S. in Elementary Education and a M.S. in Curriculum and Instruction. She has sixteen years of teaching experience ranging from preschool to the middle school levels. She taught in gifted programs, special education programs, and is an experienced classroom teacher. Most recently she has held executive board positions for child care centers and a nursery school. Currently, she studies state and national programs for teachers' professional development and school restructuring.

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