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ABSTRACT

A model program for freshman women in engineering has been developed at Purdue University. The program focuses on an experimental course that provides beginning engineering women and men with hands-on laboratory experiences, discussions of contemporary societal problems including environment, energy and productivity by various role model lecturers, and career planning. Pre-testing and post-testing with standardized tests and specially developed surveys were used to evaluate experimental and control groups, and generally positive results were obtained. The continuation phase of the program is directed at dissemination of information via a workshop, reports and audiovisual materials, and the offering of another experimental course revised to incorporate changes based upon student and staff observations and evaluation data. A syllabus, lecture schedule, and pre-test and post-test data are included. (SW)

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Title: Providing Equity for Freshman Women Entering Engineering Via Role Model Lecture-Discussions, Hands-On Laboratory and Career Planning

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Abstract

The Women's Educational Equity Act provides an important broad-ranged source of support for individuals, groups and institutions interested in developing model programs which will eliminate sex bias and broaden educational opportunities for all. For fiscal year 1976 over 4 million dollars was available and for 1977 over 7 million dollars will be available.

Purdue University received a grant of $46,523 to develop a model program in 1976 for women in engineering and is seeking a continuation grant of $68,097 for fiscal year 1977.

The Purdue program is designed to develop a model program for women in engineering. The program focuses on an experimental course which provides beginning engineering women and men with hands-on laboratory experiences, discussions of contemporary societal problems including environment, energy and productivity by various role model lecturers and career planning. Pre- and post-testing with standardized tests and specially developed surveys were used to evaluate experimental and control groups with generally positive results.

The continuation phase of the program is directed at dissemination of information via a workshop, reports and audio-visual materials and another offering of the experimental course revised to incorporate changes based upon student and staff observations and evaluation data.

PROVIDING EQUITY FOR FRESHMAN WOMEN ENTERING ENGINEERING VIA ROLE MODEL LECTURE-DISCUSSIONS, HANDS-ON LABORATORY AND CAREER PLANNING*

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Introduction

The Women's Educational Equity Act (WEEA) was passed as part of the Special Projects Act of the Education Amendments of 1974, Public Law 93-380. The enactment of the legislation was the result of two bills: H.R. 208, introduced by Congresswoman Patsy Mink on January 3, 1973 and a companion bill S. 2518, introduced by Senator Walter F. Mondale on October 2, 1973. The WEEA authorizes the support of an extremely broad range of activities with targets in every area of education that perpetuates sex bias. These include guidance and counseling, the expansion and improvement of educational programs for women, and non-traditional careers. Over 800 pre-applications for the general grant program were received and applications for the small grant program numbered slightly over 400. The final outcome of the grant process was the support of 46 general grants in the total amount of $4,350,489 and 21 small grants totalling $301,933, bringing the combined grant total to $4,652,422.[1] For the fiscal year 1977, $7,270,000 additional funds will be available for continuation grants, approximately 40 new general grants and 25 new small grant awards. Applications for small grants were due by May 25, 1977 and final general grants by June 27, 1977.[2]

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The Purdue University Department of Freshman Engineering submitted a research proposal to the U.S. Department of Education and was awarded one of the general grants in September, 1976. Purdue's proposal was for a model program to provide educational equity opportunities for women studying engineering. It was supported for two major reasons: women have traditionally not entered engineering and many enter with deficiencies due to the lack of equitable educational and cultural opportunities. Employment opportunities for women engineers are numerous and diverse,[3] but the supply of women engineers with engineering degrees is limited.[4,5] Women who enter the fields of science and engineering do so with less confidence in their technical and mechanical abilities than men who enter engineering.[6,7] This is due in part to the lack of cultural, technical and educational opportunities that have not been made available to the majority of women who enter engineering and science, i.e. women are less likely to have mechanical hobbies, read Popular Mechanics, or take shop courses.[8] These disadvantages not only result in a lack of knowledge and experience for the women who enter engineering, but also create problems of decision-making about entering engineering as a career and the selection of a field within engineering. The second decisions are also due in part to the fact that women are more apt to make their decision to enter engineering much later in their careers.[9,10]

There are varied views on whether or not separate laboratory courses for men and women should be scheduled.[11,12] Therefore, this area was also a matter of concern in the development of the model program.

Objectives

Purdue's WEEA project has four major objectives: (1) to develop a model program for women in engineering education; (2) to evaluate the effectiveness of the materials and course by offering a pilot course to test the model; (3) to disseminate the information nationally; and (4) to collect, store, and synthesize information on studies and programs for women in non-traditional fields.

Purdue's WEEA model program is aimed at overcoming the problems that many women and some men currently face when they enter a college engineering program. The model program developed at Purdue is an experimental course, Engineering 195, Engineering Skills and Career Planning. Because the problems which many women and some men in engineering face are both problems of knowledge and experience and decision-making, Engineering 195 is aimed at helping students in three areas: developing hands-on skills, discussing contemporary societal engineering problems by various role models and participating in personalized career planning.

Experimental Design of the Project

Two hundred fifty freshman engineering students applied for the course during the fall semester of 1976. From this group, 30 women were randomly assigned to one section, 15 men and 15 women were assigned to the other section, and 25 women and 30 men were assigned to the control group. After scheduling was completed for the spring semester of 1977, there were two groups of 25 students each enrolled in the course. One group consisted of 22 women and 3 men, and the other group consisted of 14 women and 11 men. Two control groups

were used in the study. One group consisted of 10 women and 5 men who originally applied for the course, were assigned to the control group, and participated in the pre- and post-testing; another back-up control group of 66 men and 4 women enrolled in a freshman engineering design course.

Major Areas of Emphasis

Engineering 195 has been divided into three areas of emphasis: the role model lecture-discussions, the hands-on laboratories, and the career counseling (Tables 1 and 2).

Role Model Lecture-Discussions

The role model lecture-discussions had three main goals. The first goal was to provide a variety of role models for women considering engineering as a profession. The role models included both minority and majority group members, women and men, young and old, and single and married individuals employed by government, industry, and the university. The second goal was to show how engineering relates to the current societal problems including energy, the environment, transportation, productivity, and biomedicine. The third goal was to demonstrate how engineering relates to a variety of disciplines. We attempted to achieve these by using various role model speakers from various engineering fields, as well as from economics, psychology, physics, and mathematics to discuss how their fields related to one of the contemporary societal problems, e.g. environment, energy, etc. (Figure 1).

TABLE 1

Engr. 195A,B

Engineering Skills & Career Planning

Lesson Assignment Sheet

Engr. 195A, T 11:30, Chm 1154, T 1:30-3:20 HH109
Engr. 195B, T 11:30, Chm 1154, Th1:30-3:20 HH109

Date	Lesson No.			TOPIC	READING ASSIGNMENT
	Counseling and Testing	Lectures	Laboratories		
Jan. 11	1			Introduction	
11,13	2			Initial Testing	
18		3		Lecture #1: Career Planning I	
18,20			4	Lab. #1: Hand Tools	
25		5		Lecture #2: "The Environment"	G&H* Chapter 5 (Scan)
25,27			6	Lab #2: Power Hand Tools	
Feb. 1		7		Lecture #3: "The Environment"	
1,3			8	Lab #3: Power Tools	
8		9		Lecture #4: "Energy"	G&H Chapter 4 (Read)
8,10			10	Lab #4: Woodwork	
15		11		Lecture #5: "Energy"	Read "Energy Handout"
15,17			12	Lab #5: Electricity	
22		13		Lecture #6: "Energy"	
22,24			14	Lab #6: Plumbing	
Mar. 1		15		Lecture #7: "Transportation"	G&H Chapter 3 (Read)
1,3	16			Career Planning II (Lab.), Test #1	
15		17		Lecture #8: "Transportation"	
15,17			18	Lab #7: Intro. to Recip. Eng.	
22		19		Lecture #9: "Bio-Medical"	G&H Chapter 10 (Scan)
22,24			20	Lab #8: Small Engines	
29		21		Lecture 10: Career Planning III	
29,31			22	Lab #9: Intro. to Automotives	
Apr. 5		23		Lecture #11: "Bio-Medical"	
5,7			24	Lab #10: Auto Safety Inspection	
12		25		Lecture #12: "Productivity"	
12,14			26	Lab #11: Auto Tune-up	
19		27		Lecture #13: "Productivity "	
19,21			28	Lab #12: Turbine Engines	
26	29			Test #2	
26,28	30			Final Testing and Course Wrap-up	

TESTING - Bill LeBold
CAREER PLANNING - Christie Smith

*Note: 1. Purdue Energy Conference scheduled for 29,30 April 1977
2. G&H refers to Intro. to Engineering text by Glorioso & Hill.

TABLE 2

LECTURE SCHEDULE - ENGR 195A

Spring 1977

Date	Topic	Speaker(s)
Jan. 18	Career Planning I	Christine Smith Counselor/Freshman Engineering
Jan. 25	Environment	Lorel Au - Eastman Kodak Gwendolynn Albert - Environmental Protection Agency Environmental Engineering
Feb. 1	Environment	Prof. Kenneth Friedman Political Science
Feb. 8	Energy	Prof. Gerry Heydt Electrical Engineering
Feb. 15	Energy	Prof. R. E. Bailey Nuclear Engineering
Feb. 22	Energy	Prof. Keith Brown Management
Mar. 1	Transportation	Ann Muzyka Dept. of Transportation
Mar. 15	Transportation	Prof. Alan McDonald Prof. Raymond Goodson } Panel Discussion Mechanical Engineering
Mar. 22	Bio-medical	Dianne Rekow Bio-medical Engineering
Mar. 29	Career Planning II	Christine Smith Counselor/Freshman Engineering
Apr. 5	Bio-medical	Prof. Leslie Geddes Bio-medical Engineering
Apr. 12	Productivity	Fred Wood F-16 Project Office, Wright-Patterson AF
Apr. 19	Productivity	Prof. Harold Amrine Industrial Engineering

The role model lecture-discussions were primarily concerned with showing both the diversity of people in engineering fields and the diversity of people who are concerned in one way or another with engineering-societal problems. Helping students see what various engineers actually do was also a primary concern of the lecture-discussions.

Hands-On Laboratories

The hands-on laboratories had two important goals. The first goal was to familiarize students with basic hand and power tools and equipment. The second goal was to increase their confidence and ability to study engineering by developing basic skills and their knowledge of technical information, which many of them did not have prior to entering engineering.

The laboratories have involved a variety of activities in the Department of Aviation Technology at the Purdue Airport which included working with hand tools, power tools, metals, and electricity; disassembly and reassembly of lawn mower engines, safety inspection and tune-up of automobiles, and a test demonstration of a turbine engine. The primary concern of the hands-on laboratory is providing the student participants with knowledge and experiences related to engineering and technology (Figure 2).

Career Counseling

The career counseling was the third area of emphasis in the experimental course. The three major goals were: to define and explore various engineering disciplines, to identify the students' abilities and interests, and to integrate their understanding of the fields of

engineering and their interests and abilities into a plan of action (Figure 3).

The career planning sessions included a lecture-discussion emphasizing the interaction of interests, abilities, goals and aspirations in career choice. It also included an interpretation of the Strong-Campbell Interest Inventory and Purdue Engineering Interest Questionnaire. The last class was given a final open-ended assignment in which students were asked to write their biographical introductions to be given at a banquet at which they were to be the principal speaker at age 50 (Figure 4). The career counseling was primarily concerned with the decision-making process, which women in particular face when they consider engineering as a career choice and attempt to decide upon an area within engineering.

Student journals, giving their impressions of each class session, were another important aspect of the career planning. Appendix I gives some comments students wrote in their journals about the role model lecture-discussions, the hands-on laboratories and the career counseling.

Evaluation

Evaluation of the project included the use of standardized tests for assessing knowledge in technical and mechanical areas included in the laboratory portion of the class, a survey developed for the project to measure experiences, interests, and attitudes, and a job interest questionnaire. Students' journals expressing their impressions of each lecture and laboratory was also used for evaluation. Existing data about each student in the study taken from Purdue's Freshman Engineering Data Bank was also used to help evaluate the success of the

project. The standardized tests used in the study include the Tool Knowledge Test, the Mechanical Information Test, and the Electrical Information Test from Educational Testing Service; the Auto Mechanics Test and the Mechanics Test from Science Research Associates; the Bennett Mechanical Comprehension Test from the Psychological Corporation; and the Purdue Mechanical Adaptability Test and the Job Activity Preference Questionnaire from the Purdue Research Foundation.

The standardized tests and the survey were administered during the first week of classes as pre-tests and re-administered during the last week of classes as post-tests. The pre-test results indicated statistically significant higher means for men than women but no differences in means for control and experimental groups on most of the tests except for the Tool Knowledge Test where the experimental group was slightly higher. The post-test results indicated statistical significant higher means for men than women, but the mean differences became much smaller in the experimental courses (Table 3).

Dissemination

Dissemination of information about the model program has taken various forms. Video tapes have been provided and utilized for a number of Indiana television stations for public service spots. The Associated Press has released a feature story focusing on one of the student participants. The staff will present papers at various professional meetings including this 1977 American Society of Engineering Education Annual Conference and the 1977 ASEE-IEEE Frontiers in Education Conference.

TABLE 3

SUMMARY OF MEANS AND RELATED DATA ON PRE- AND POST-TESTS OF EXPERIMENTAL AND CONTROL FEMALE AND MALE PARTICIPANTS IN PURDUE EXPERIMENTAL COURSE

	PRE-TEST						POST-TEST						
	TOTAL		EXPERIMENTAL		CONTROL		TOTAL		EXPERIMENTAL		CONTROL		
VARIABLE	$\bar{X}$	SD	F	M	F	M	$\bar{X}$	SD	F	M	F	M	MAXIMUM SCORES
PMA	28.0	10.5	21.7	33.6	20.7	32.1[1,4]	31.4	9.8	27.4	39.2	24.4	33.6[1,4,9]	60
BMC	52.5	7.2	47.7	58.5	49.1	54.8[1,4]	53.7	7.0	50.6	58.8	51.5	54.8[1,4]	68
TKT	19.9	4.8	15.9	24.6	15.1	22.3[1,4,9]	20.9	4.5	18.0	25.6	16.9	22.5[1,4,8]	30
MIT	18.1	5.8	14.8	20.8	13.6	20.5[1,4]	20.2	5.1	18.7	24.4	14.4	21.4[1,4,7]	30
EIT	18.9	5.0	16.1	20.7	14.9	21.1[1,4]	20.5	4.3	18.7	23.0	16.6	21.8[1,4,9]	30
AMT	4.5	2.7	3.2	5.1	2.9	5.4[1,4]	5.3	3.0	3.9	6.9	4.1	6.0[1,4]	20
MCT*	9.6	4.5	8.1	13.9	7.1	13.3[1,4]	11.3	5.0	9.9	16.8	7.7	12.7[1,4,9]	30
(NO. OF CASES)	(129)		(37)	(14)	(14)	(64)	(129)		(37)	(14)	(14)	(64)	

*Control groups smaller on MCT (Female = 10 and Male = 6)

PMA = Purdue Mechanical Adaptability Test
BMC = Bennett Mechanical Comprehension Test
TKT = Tool Knowledge Test
MIT = Mechanical Information Test
EIT = Electrical Information Test
AMT = Auto Mechanics Test
MCT = Mechanics Test

[1]Significant difference at the $p < .001$ between all groups
[2]Significant difference at the $p < .01$ betweel all groups
[3]Significant difference at the $p < .05$ between all groups
[4]Significant difference at the $p < .001$ between sex
[5]Significant difference at the $p < .01$ between sex
[6]Significant difference at the $p < .05$ between sex
[7]Significant difference at the $p < .001$ between experimental and control groups
[8]Significant difference at the $p < .01$ between experimental and control groups
[9]Significant difference at the $p < .05$ between experimental and control groups

A Purdue WEEA Workshop is being planned for December 1-2, 1977, for further dissemination of information and for feedback from persons who attend, giving their impressions of the model program. Representatives of educational institutions, professional societies, industry, and government will be invited to attend. We are also considering inviting outside speakers to discuss relevant women-in-engineering programs at other institutions. Participants may be given "mini-experiences" similar to those that the students in the experimental course had during the spring semester.

A final report will be issued at the completion of the project describing the model program. The materials will be made available to other U.S. universities and colleges with engineering programs.

Future Plans

Future plans will be dependent on the availability of funds being sought under a continuation grant. If funded the staff plans to revise the experimental course and offer the revised course during the spring semester of 1978. Revisions will occur in all phases of the course, although the scope of the course will remain unchanged. The student journals and evaluation data indicated that although the students enjoyed the course and we seemed to achieve our objectives, there exists a need for improvements beyond the fine tuning of the model program.

The role model lecture-discussions will be revised so that they are more closely related to the laboratory experiences. The speakers will be encouraged to allow more time for class discussion and student interaction. More speakers from disciplines outside of engineering will be scheduled to show how other disciplines relate to engineering.

During one session an engineer and a non-engineer in a related area might present a panel discussion; in another, joint male and female speakers may discuss a topic. An attempt will be made to broaden the role models to include more minority guest lecturers and perhaps a handicapped person.

The hands-on laboratories will be revised in two major ways. First of all, students will be given more hands-on experiences. Secondly, the laboratory experiences will be more related to engineering and engineering design.

The career counseling revisions will consist of three major improvements. The first of these is the expansion of the career planning materials. More intensive exercises will be developed by the staff. Secondly, more time by the staff will be spent on individual interpretations of interest inventories and career counseling. Finally, more attention will be directed towards the assessment of student needs of the two groups that have been identified. The first group of students is concerned with whether to stay in engineering. The second group is concerned with identifying a field within engineering. Separate programs will be developed for each group.

The project evaluation will also undergo revision. Project evaluation will be made more relevant to the students, and the purpose and importance of evaluation will be emphasized. Existing cognitive and affective measures will undergo revision to be more directly related to the goals of the project. Short term evaluation of the revised course, as well as longer term evaluation of the students who completed the course in the spring of 1977 will be completed.

At this time the project's co-principal investigators are also considering organizing the course into three mini-courses, including career planning, role model lecture-discussions, and hands-on laboratories. This might more closely meet the diverse needs of individual students who enter engineering. This organizational scheme could help avoid the problem of having students enroll in a course which is partially a duplication of previous knowledge or experiences. The coordinators and investigators also plan to develop the course or mini-courses so they can be considered a viable option of the current freshman engineering design-orientation computer requirement.

Summary

The Women's Educational Equity Act provides an excellent resource for obtaining funds to develop model programs designed to restore and to insure equal educational opportunities for men and women. Purdue has developed an experimental course designed to meet the needs of freshman engineering women, as well as men. The course includes: (1) a hands-on laboratory, (2) lecture-discussions of contemporary engineering-societal problems, and (3) career planning. The preliminary evaluation results of cognitive and affective variables indicate very positive results. Plans are underway to modify and improve the course. The results of the project will be disseminated through a workshop project report and educational materials.

Figure 1. Gwendolyn Albert of the U.S. Environmental Protection Agency discusses water pollution problems in Texas.

Figure 2. On the small engines laboratory, Engineering 195 students learn how to disassemble and reassemble lawn mower engines.

Figure 3. Christine D. Smith interprets the Strong-Campbell Interest Inventory for an Engineering 195 student during a career counseling session.

Figure 4. Blaine R. Butler, William K. LeBo and Bonnie Heckert discuss the pre test results.

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APPENDIX I

VERBATUM COMMENTS FROM STUDENT JOURNALS ON ENGINEERING SKILLS AND CAREER PLANNING

Testing

Took tests - felt like a real dummy. I did not know any of the answers. The tests made me feel like I should be a mechanic to be in this course.

Laboratory

Lab was great! Lab is the best part of the class. Started on a mitre box. Measured wood, sawed it off, hammered nails, and different fun kind of things to do. It's an excellent way to relieve one's frustrations, especially hammering nails. This is about the first lab I have ever looked forward to, so I know it must be good.

Lecture-Discussion

This lecture uprooted my awareness and concern about the non-happenings going on about the problem dealing with energy - progress or acceptance of this process of filling the gap at a snail's pace. The lecture was very clear and informative.

Career Planning

I found that filling out career guide was very beneficial. It made me think about the things I'm good at and the things I like to do. Although I have given much thought to my career plans and objectives, it is good to revise them periodically.