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ABSTRACT

Educational goals were presented to faculty involved in a group of eight team taught interdisciplinary (TTI) courses and were rated in terms of their importance to the courses as a group. The goals rated highest by the faculty were then presented to students enrolled in one of the TTI courses during the first and last weeks of the semester and were rated in terms of importance to the student and achievement in the course. Results were correlated with interest, difficulty, and quality ratings of the course in which the student was enrolled. (Author)

EXPECTATIONS OF UNIVERSITY STUDENTS IN TEAM TAUGHT INTERDISCIPLINARY COURSES

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In the past, liberal arts courses were included in engineering curricula so that engineering graduates could assume their role in society as college-educated citizens. As technology has grown, the pressure for more and more technical requirements has increased in engineering curricula at the expense of non-technical electives. While engineering schools have been careful to include room for "general education" courses and non-technical electives in their degree requirements, the non-technical courses offered in other schools of the University rarely have any relevance to the profession to which the young engineer aspires.

In the Spring of 1974, a group of eight experimental courses, called the Man Series, was instituted at Purdue for the purpose of improving the social dimensions of engineering education. Each course was to address itself to a specific topic and, hopefully, demonstrate the value of synthesizing multiple perspectives into interdisciplinary approaches to problem solving. Each course was to be team taught by at least one faculty member from the Schools of Engineering and at least one faculty member from one of the other schools within the University. The classes were to be truly interdisciplinary - putting together in the same classroom, at the same time, faculty from Engineering, Philosophy, Economics, Fine Arts, Sociology, Biology, Political Science, Agriculture, and Industrial Management in various combinations. In this way, non-technical perspectives could be incorporated into the problem-solving process which is the fundamental characteristic of the engineering profession.

The courses were made possible through a grant from the Alfred P. Sloan Foundation. In order to aid the reader in understanding the breadth of course offerings and the diversity of faculty involved, a brief description of each course will be presented.

Man, Aesthetics and Public Works discussed those man-made structures which are not considered or defined as architecture, but which are made for practical use, often without aesthetic consideration. Bridges, dams, watertowers, gas tanks, silos, super-highways are typical of the structures which were discussed. Visual polution and man's relationship with nature were considered when the class discussed man's responsibility for creating his own environment. Faculty represented Civil Engineering, Biology, and Creative Arts.

Man and Energy provided student and faculty interaction by establishing task forces which attacked various different problems related to the energy dilemma. Lectures were used only when factual background material was needed to establish a foundation knowledge and to provide course continuity. Faculty represented Chemical Engineering, Economics, History, Political Science, Nuclear Engineering, and Mechanical Engineering.

Man and the Environment considered cultural attitudes towards nature, legal precedents for governmental intervention, as well as strategies of regulation. The specific cases of water and air pollution, solid wastes and land use control were used to explore the environmental crisis. Engineering aspects of the environmental problem and their relationship to public policy were considered in exploring policy alternatives and in considering their engineering implications. Also considered were the criteria used to assess the human costs of growth and development, as well as the possible impact on different groups of the various policy options available. Faculty represented Political Science, Philosophy, Economics, and Civil Engineering.

Man and Health Care. In addition to consideration of the contributions of the basic sciences and engineering to medical progress, the socioeconomic and political aspects of the public expectations with respect to health care were examined. The components of the health care system, institutions and personnel, were analyzed in detail. The application of the techniques of systems analysis to securing the optimum utilization of the health care system was emphasized. This course also focused on the problems of the consumer-patient and his rights and expectations, health maintenance and disease prevention, treatment for disease, accessibility of health care, and financing the health care system. Faculty represented Sociology, Political

Science, Aeronautics and Astronautics, History, and Industrial Engineering.

Man as Engineer in History was a study of the historical development of engineering theory and practice and of the role of the engineer in history and society. The course had two major thrusts: a discussion of the significant advances in engineering knowledge, and a study of both the impact that existing social and economic forces had on the work of engineers and the impact that those engineers had in turn on the economies and societies in which they worked. Faculty represented History, Economics, and Mechanical Engineering.

Man and Law Enforcement took a comprehensive look at law enforcement policies and processes in the United States. The course considered not only street crime, but white collar crime, political crime, corporation criminal violations, environmental criminal offenses, and organized crime. Faculty represented Political Science, Industrial Management, and Industrial Engineering.

Man and his Models considered various analytical and computer simulation models of human behavior and attempted to assess their current and potential contribution to the improvement of social systems. Faculty represented Industrial Engineering and Sociology.

Technology and Values was concerned with the impact of science and technology on emerging personal and societal value systems, as well as the development of practical means by which human values may guide future technological considerations. The role of industry, educational and research establishments, government, and man were examined in light of both optimistic and pessimistic views of technology. Some specific points of discussion were the following: technological goals and forecasts, corporate and moral conflicts, ethics of economic growth, value system changes, nature of work, alienation and freedom, technological benefits of social, political, and economic reform, and personal obligations to society. Faculty represented Mechanical Engineering, Industrial Management, Administrative Science, Political Science, and representatives from the Campus Ministry.

As an integral part of the project, a series of ongoing evaluation studies was instituted to document the development, execution, and impact of these courses on students and faculty. This paper reports the findings of a series of questionnaires given to faculty and students who participated in the first offerings of the Man Series.

In evaluating the Man Series, a number of factors had to be considered. Probably the most difficult was to determine what the courses had in common, other than the fact that they were taught by interdisciplinary teams. It would seem obvious that since the issues which served as the foci of the courses were different for each course, the actual course content was not the end towards which the series was directed. Thus, the evaluation of the series as a whole did not need to address itself to specific course content.

Furthermore, while the underlying motivation for the institution of the Man Series was aimed at engineering students, these were not the only students anticipated in the course. The courses were cross-listed in each school represented by the faculty comprising the interdisciplinary teams and sought to attract students from all parts of the University. This diversity of students would, it was hoped, further enhance the presentation of a broad spectrum of ideas and perspectives on an issue.

Thirdly, since the courses were electives, it was possible that the students who chose to take a Man Series course (especially the engineering students) would be more inclined to pursue broad perspectives and a diversity of ideas than students who chose other, more traditional electives.

In order to determine specific goals for the series, the Man Series Goals Inventory was developed. This inventory listed a group of educational goals selected from the ETS Institutional Goals Inventory; the recommendations of the American Society of Engineering Education Report, "Liberal Learning for the Engineer;" the Sloan Foundation Annual Report, 1972; the Man Series grant proposal to the Sloan Foundation; and from interviews conducted with the "lead professors" of each course. Twelve goals were rated as "Extremely" or "Very" important goals of the series as a whole by over 80% of the faculty who were involved in the Man Series. In this way, a manageable set of usable goals was determined for the series without regard to any specific course content.

The second consideration alluded to above concerned the diversity of students who would be attracted to the courses. The student questionnaires asked for demographic information so that the analyses could distinguish engineers from non-engineers. This consideration was further alleviated by the fact that the goals were worded so that most of them did not directly address engineers.

The third problem, that of possible entry differences, was dealt with by the use of a control group. A course in abnormal psychology was chosen to serve this function because it had approximately the same number of students as the total Man Series and had a wide diversity of students, including a number of engineering students. Also, the abnormal psychology course is a popular elective for many students as well as being a required course for others; and it consistently rates highly on student evaluations.

The goals which were rated highest in importance by the Man Series faculty as goals of the series as a whole are listed in Table 1. Eight of these ten goals were presented to the students enrolled in the Man Series and the Abnormal Psychology courses during the first week of classes as part of the Man Series Preliminary Survey. This survey included a number of other educational goals and other items not relevant to the present discussion. The students were asked to rate the goals on three dimensions: importance to themselves, achievement so far at Purdue, and achievement expected in the course in which the questionnaire was given to them. In order to test the hypothesis that the engineers enrolled in the Man Series were more socially conscious-or were more inclined to sympathize with interdisciplinary efforts-and thus would be the very engineers who would benefit least from exposure to the Man Series, the responses of the engineers in the two groups (Man Series vs. Abnormal Psychology) were compared by means of the chi square test for significance of differences. These data are presented in Table 1.

It is plainly clear from Table 1 that the only goal on which the groups differed on importance ratings was number 2: "To critically evaluate the prevailing practices and values in American Society." Thirty-five percent of the Man Series engineers rated this goal extremely important, while only 6% of the Psychology engineers rated it extremely important. Likewise, in ratings of achievement thus far at

TABLE 1.

PERCENTAGES OF ENGINEERING STUDENTS IN MAN SERIES COURSES AND IN THE ABNORMAL PSYCHOLOGY CONTROL COURSE INDICATING EXTREMELY AND VERY IMPORTANT, AND MUCH OR SOME ACHIEVEMENT OF SELECTED EDUCATIONAL GOALS

GOALS	Importance to you personally / Achievement thus far at Purdue / Achievement expected in this Course	MAN SERIES EXTR / MUCH / MUCH	MAN SERIES VERY / SOME / SOME	PSYCHOLOGY EXTR / MUCH / MUCH	PSYCHOLOGY VERY / SOME / SOME	
1. To develop the ability to synthesize knowledge from a variety of sources.	Importance	60%	38%	69%	25%	
	Ach. Purdue	19%	58%	25%	56%	
	Exp. Ach.	38%	51%	6%	75%	*
2. To critically evaluate the prevailing practices and values in American society.	Importance	35%	35%	6%	44%	*
	Ach. Purdue	4%	37%	6%	38%	
	Exp. Ach.	38%	48%	6%	56%	*
3. To develop awareness of and sensitivity to the broad social dimensions of contemporary engineering practice.	Importance	68%	32%	53%	40%	
	Ach. Purdue	6%	66%	29%	14%	**
	Exp. Ach.	39%	50%	21%	14%	***
4. To broaden and deepen my understanding of a society which is committed to an increasing use of science, engineering, and technology.	Importance	54%	35%	47%	47%	
	Ach. Purdue	13%	63%	27%	33%	
	Exp. Ach.	49%	45%	13%	13%	***
5. To interact with students from different disciplines.	Importance	23%	56%	27%	60%	
	Ach. Purdue	13%	31%	33%	20%	
	Exp. Ach.	32%	51%	27%	40%	
6. To develop an interdisciplinary approach to problem-solving.	Importance	50%	35%	27%	60%	
	Ach. Purdue	9%	50%	20%	33%	
	Exp. Ach.	28%	54%	27%	13%	**
7. To examine contemporary technological issues from a variety of points of view.	Importance	42%	44%	33%	47%	
	Ach. Purdue	6%	56%	13%	33%	
	Exp. Ach.	36%	53%	7%	36%	**
8. To gain an understanding of the principal changes which are taking place in the contemporary world, considered as an interacting whole.	Importance	45	33	31	44	
	Ach. Purdue	0	63	13	44%	*
	Exp. Ach.	35	50	13	5	

* Differences Significant at .05 level
** Differences Significant at .01 level
*** Differences Significant at .001 level

Purdue, the groups differed only on goal number 3, "To develop awareness of and sensitivity to the broad social dimensions of contemporary engineering practice." In this case 29% of the Psychology engineers indicated much achievement, while only 6% of the Man Series engineers indicated much achievement. The expected achievement ratings differed quite significantly on most of the goals; and given the nature of the two groups, this is not surprising since the psychology course was not aimed at these goals. The data from the Man Series courses alone showed no consistent differences between courses on any of the scales. Thus, these data suggested that the engineers who were enrolled in Man Series courses were not different from those engineers enrolled in an arbitrarily-selected, non-technical elective; and these engineers were fairly homogeneous across Man Series courses in their ratings of these educational goals. Furthermore, the ratings of all respondents in the Man Series did not differ consistently between courses across all dimensions of the ratings.

At the end of the semester, the Man Series Course Survey was administered in class during the last week of classes. A similar questionnaire was given to the students in the psychology course. Students were asked to rate their course as to general quality, difficulty, and interest as well as a number of other items. Included were the goals of Table 1 with two more goals added. Students were asked to rate the goals on two dimensions: their importance to them and whether they were achieved in the course. As with the preliminary survey, the importance ratings did not differ consistently between Man Series courses. However, the courses differed significantly in achievement on all but one of the goals - the one which was consistently rated lowest in achievement across courses. The percentage ratings by course for achievement are shown

TABLE II.

PERCENTAGES OF STUDENTS INDICATING "MUCH" OR "SOME" EXPECTED ACHIEVEMENT AT THE BEGINNING OF THE COURSE AND PERCEIVED ACHIEVEMENT AT THE END OF THE COURSE

GOALS		TOT	RAD	A&P	ENG	ENV	HEA	HIS	LAW	MOD	T&V	PSY*
1. To develop the ability to synthesize knowledge from a variety of sources.	Exp Ach**	93	100	100	90	86	90	83	97	89	100	90
	Per Ach	76	85	75	100	68	87	85	59	71	87	61
	Difference	17	15	25	-10	18	3	-2	38	18	13	29
2. To critically evaluate the prevailing practices and values in American society.	Exp Ach	85	83	91	83	86	100	43	97	33	100	73
	Per Ach	71	85	58	89	72	87	68	58	29	87	78
	Difference	14	-2	33	-6	14	13	-25	39	4	13	-5
3. To develop awareness of and sensitivity to the broad social dimensions of contemporary engineering practice.	Exp Ach	74	25	80	97	86	79	71	53	67	100	29
	Per Ach	61	46	67	74	79	33	75	35	29	87	31
	Difference	13	-21	13	23	7	46	-4	18	38	13	-2
4. To broaden and deepen my understanding of a society which is committed to an increasing use of science, engineering, and technology.	Exp Ach	83	50	82	97	95	74	100	73	78	100	44
	Per Ach	69	69	67	93	71	60	79	48	14	100	57
	Difference	14	-19	15	4	24	14	21	25	64	0	-13
5. To interact with students from different disciplines.	Exp Ach	85	50	100	93	86	100	71	87	56	80	64
	Per Ach	53	15	100	86	44	62	29	47	100	53	51
	Difference	32	35	0	7	42	38	42	40	-44	27	13
6. To develop an interdisciplinary approach to problem solving.	Exp Ach	82	58	100	83	86	90	71	70	100	89	53
	Per Ach	56	69	64	71	59	53	47	44	43	68	55
	Difference	26	-11	36	12	27	37	24	26	57	21	-2
7. To examine contemporary technological issues from a variety of points of view.	Exp Ach	88	58	91	97	96	90	86	83	78	100	49
	Per Ach	70	62	75	93	80	73	65	47	43	93	34
	Difference	18	-4	16	4	16	17	21	36	35	7	15
8. To gain an understanding of the principal changes which are taking place in the contemporary world, considered as an interacting whole.	Exp Ach	89	83	90	94	100	90	61	88	56	100	74
	Per Ach	61	54	25	82	67	73	62	46	29	93	68
	Difference	28	29	65	12	33	17	-1	42	27	7	6
9. To encourage engineering students not only to benefit from the social sciences, but in some degree to contribute to them.	Exp Ach	This item was not included on the preliminary form										
	Per Ach	56	38	67	64	56	27	72	41	57	87	44
10. To interact with faculty from different disciplines.	Exp Ach	This item was not included on the preliminary form										
	Per Ach	66	25	92	82	64	67	74	53	57	79	30

* TOT=Total Man Series, RAD=Radio broadcast of Man & Law, A&P=Man, Aesthetics & Public Works, ENG= Man & Energy, ENV= Man and the Environment, HEA=Man and Health Care, HIS= Man as Engineer in History, LAW=Man & Law Enforcement, MOD= Man & Models, T&V= Technology & Values, PSY=Abnormal Psychology. **Exp Ach= Expected Achievement, Per Ach= Perceived Achievement

in Table II. With few exceptions, the students' expectations exceeded their perceived achievement. Where the perceived achievement was greater than the expected achievement, it is indicated in the difference row as a negative number.

Students were asked to give a general rating of their course using a scale of "Excellent", "Good", "Average", "Fair", or "Poor", as well as an indication of their interest (from Very high to Very low) and how difficult they thought the course was (from Very difficult to Very easy). The importance ratings of the goals in general were not significantly correlated with the general ratings or difficulty ratings. On the other hand, all but one of the achievement ratings were significantly correlated ($p < .001$) with general ratings of the course and with interest ratings. None of the ratings of the goals, on either the importance ratings or achievement ratings, were correlated significantly with difficulty ratings.

Students were asked if the course fulfilled their expectations. Responses to this item were correlated significantly with overall rating ($r = .7641$, $p < .001$) and interest ($r = .5044$, $p < .001$). Students were also asked what they felt the objectives of the course should be. Their ratings of achievement of their objectives were also correlated with rating of the course ($r = .6845$, $p < .001$). The correlations of the ratings of the goals with overall rating of the course and with interest and difficulty ratings are shown in Table III.

DISCUSSION

In recent years there has been great interest among engineering schools in improving the liberal education of engineering students (ASEE 1968a, 1968b). While programs aimed at improving the liberal education of engineers are found in many colleges and universities,

TABLE III

CORRELATIONS BETWEEN IMPORTANCE AND ACHIEVEMENT RATINGS OF THE GOALS WITH GENERAL RATING, INTEREST RATING, AND DIFFICULTY RATING

GOALS		IMPORTANCE WITH GENERAL RATING	ACHIEVEMENT WITH GENERAL RATING	IMPORTANCE WITH INTEREST	ACHIEVEMENT WITH INTEREST	IMPORTANCE WITH DIFFICULTY	ACHIEVEMENT WITH DIFFICULTY
1. To develop the ability to synthesize knowledge from a variety of sources.	r	.0399	.4499	.1904	.4243	-.0788	.1317
	sig	.275	.000	.002	.000	.119	.026
2. To critically evaluate the prevailing practices and values in American society.	r	.0134	.4177	.1283	.3058	.0559	.1335
	sig	.421	.000	.028	.000	.202	.024
3. To develop awareness of and sensitivity to the broad social dimensions of contemporary engineering practice.	r	.1782	.3791	.2458	.2723	.0991	.2051
	sig	.004	.000	.000	.000	.071	.001
4. To broaden and deepen my understanding of a society which is committed to an increasing use of science, engineering, and technology.	r	.1862	.4697	.2594	.3062	-.0654	.0292
	sig	.003	.000	.000	.000	.167	.334
5. To interact with students from different disciplines	r	-.0424	.0888	.0785	.1285	.1263	.0099
	sig	.265	.094	.123	.028	.030	.442
6. To develop an interdisciplinary approach to problem solving.	r	.0429	.3620	.1725	.3033	.1286	.0659
	sig	.263	.000	.005	.000	.028	.165
7. To examine contemporary technological issues from a variety of points of view.	r	.2093	.4046	.2012	.2758	-.0216	.0284
	sig	.001	.000	.001	.000	.375	.338
8. To gain an understanding of the principal changes which are taking place in the contemporary world, considered as an interacting whole.	r	.1657	.3542	.1709	.2069	.0751	.0307
	sig	.007	.000	.005	.001	.133	.326
9. To encourage engineering students not only to benefit from the social sciences, but in some degree to contribute to them.	r	.0548	.4002	.1329	.2694	-.0254	-.0185
	sig	.210	.000	.025	.000	.353	.393
10. To interact with faculty from different disciplines.	r	.1930	.3456	.1910	.2401	.1105	.1107
	sig	.002	.000	.002	.000	.052	.052

few of these programs incorporate any evaluation of program goals in their developmental framework. This may be the result of a feeling that one cannot measure such variables as liberal education or that the goals of the program are so general that they cannot be clearly specified. Further discouragement comes from reading the current leaders in educational evaluation (Mager, 1973; Popham, 1973) who emphasize behavioral objectives and specific course goals and totally ignore general program goals and the means of measuring their attainment.

The present study demonstrates that students are capable of differentiating very general goals and that achievement of general goals is related to the overall evaluation which a student gives to a course. Furthermore, these data also demonstrate that general program goals can be evaluated without reference to the specific content of the course.

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