University Studies . . .
interdisciplinary PUBLICATIONS

INTERDISCIPLINARY (That much abused word)

by Wain Saeger 1976

The title of this number of TEACHING LEARNING ISSUES jumped from a comment in a recent article by Robin Scott Wilson (1973), associate director of the Committee on Institutional Cooperation. He pinpoints the hallmarks of interdisciplinary or bridging courses by observing that such approaches:

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1. focus on certain commonalities between the arts or humanities or social sciences on the one hand and science and technology on the other.
2. recognize that creativity is the common element in all valid intellectual endeavor and require student participation in the creative process.
3. are frequently problem-oriented, relevant to matters of contemporary social concern:
4. sacrifice breadth for intensity and rigor on the assumption that to know a piece of a problem well is to learn a little bit about the whole of it:
5. suit students in any discipline in any field–the indiscriminant mixing of such students in a single course is in itself a valuable function;
6. aim at putting back together the humpty-dumpty of knowledge–something all the king's horses and all the kings men have so far been unable, or unwilling to do.

In academic circles there has been stern resistance to change and/or invasion of traditional disciplinary imperatives. But today, in a knowledge exploding and interacting global village where no discipline has all the questions or answers, some faculty and administrators are seeking a fresh image of the processes of learning. If we are to judge by the wondrous claims found repeatedly in a wide variety of literature, interdisciplinary courses are the long-sought panacea. This piece, then, will scrutinize reports about interdisciplinary courses and programs, with particular emphasis upon their captious evaluation procedures. In this regard Wilson's observation may be translated into criteria for evaluating interdisciplinary courses and programs; even though not all encompassing, they should provide stimulation for postulating additional ones.

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A chimerical consensus exists among practitioners about the meaning of the concept interdisciplinary, hence a definition is offered as a touchstone. Paraphrasing Piaget (1972), interdisciplinary may be defined as cooperation among disciplines or subdisciplines leading to actual interactions and reciprocity of exchanges which result in mutual enrichment. Furthermore, interdisciplinary teaching is non-traditional in that it must involve faculty in extensive planning. As Abt (1972) has asserted:

> An interdisciplinary group consists of individuals trained in different fields of knowledge with different concepts, methods, and datea and terms organized into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines. (p. 26)

A LITERATURE SEARCH

What follows is a potpourri of reports about recent interdisciplinary courses and programs. These will provide both positive and negative guidance as well as addressing whether the wondrous claims have been justified.
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- 1) Dunstone (1973) describes a course in the chemistry of silicates for freshmen. (A full page of course topics is presented at the end of the study.) It was taught by a chemistry professor; there was continuous interdisciplinary guidance from members of the geology staff who also attended the class regularly.

  Approximately twenty students participated each of the two times the course was offered. In general, they were enthusiastic and their performance appeared to be better than that exhibited by these same students in the prior introductory chemistry course. Specifically, depth and direction of instruction fostered students' ability in interpreting, in three dimensions, the textbook illustrations of mineral structures (supporting test data are not reported).

  Student feedback was laudatory about four features of the course: 1) small class size and the consequent effective faculty-student contact, 2) its interdisciplinary and applied nature, 3) the continuity provided by having only one lecturer, and 4) the presence of members of the Geology Department. The major complaint was insufficient course credit for the large amount of material covered.

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- 2) Results of an evaluation of a multi-disciplinary effort at The University of Tulsa are reported by Luce and Bolksdorf (1972). The primary purpose of the course, "Science, Technology, and the Environment," taught by a bevy of experts, was that of bringing about an increased knowledge of environmental events and problems as reported in the mass media. The 61 students enrolled were administered a pre- and post-Environmental Awareness Scale. The results indicated no heightened awareness on the part of the students; to the contrary, there was a decline in average scores. Indeed, their score was lower than was the average post score for a control group of 247 students selected as a stratified random sample.

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- 3) In an important case study, Stevens and Cohen (1974) analyze an interdisciplinary curriculum for

freshman engineering students at Northwestern University. The program consisted of an interdisciplinary senior faculty and student team involving engineers, physicists, chemists, and mathematicians–all with reputations for teaching excellence. Recognizing that not all faculty would be interested in spending all their time teaching freshman, a three-year rotation period was provided. Courses were to emphasize: 1) casual, but close faculty-student contact; 2) manual and cognitive exposure to research; 3) oral and written presentations; and 4) better integration of course material.

The actual format consisted of blocks of instruction (conceived as being a suitable mix of related materials) which were taught simultaneously to two classes of 30 trial students. Two faculty members, often an engineer and a scientist or mathematician, were responsible for each block. Prior to institution, however, their detailed plan and proposed schedule were discussed by the entire staff. Before and after measures were obtained for both trial and regular students. The analysis stressed both *student satisfaction* (as indicated by students' own feelings and by their continued interest in engineering after they left the program) and *academic achievement*.

Questionnaires were sent to the two groups of students: 1) during New Students' Week, 2) at the end of the quarter, and 3) at the end of Spring Quarter–there were no initial differences between the trial and regular students. During the year, however, satisfaction with faculty-student interaction increased more in the trial program, as did satisfaction with the opportunity for independent behavior. Additionally, the trial group was less content with University social life and with training in their major field than was the control group.

A variety of criteria were utilized in evaluating academic performance. Examination results showed that "at the end of the first quarter of calculus in the first year of the trial group, the median score was 63 percent, compared to 52 in the normal program. At the end of the third quarter of calculus, the grades were 66 percent versus 55 percent." (p. 579.) Although the results of the American Chemical Society Examination for first-year chemistry were not available for the control group, 56 percent of the trial students scored at the fifty-fifth percentile or higher and 23 percent had upper quartile scores.

One measure of the long-range academic effectiveness of the program was obtained by a surprise test on physics given during the sophomore year in a mechanics course–about half of the students had been in the trial program during their freshman year. These students had an average score of 58 percent, while students from the regular program averaged 62 percent. There was no difference between the average final grades.

Finally, the performance of students during the second year was analyzed by inspecting their grades. "During the first two quarters of this second year, there was no significant difference in the median of the grade point averages, or in their distribution. While 14 percent of the grades of the students who had been in the normal freshman program were D or lower, only seven percent of the grades of students from the trial program were so low." (p. 583.) Trial student attrition was 13 percent below that of the students in the regular program.
The authors concluded:

> By vote of the faculty, the program has now become a permanent option for all entering freshmen, for it is clear that the students finish with a feeling of belonging, and of feeling

comfortable at the University and in engineering. The faculty involved have an on-going interest in the freshman year and are in close contact with one another. Moreover, the decreased loss rate from engineering may well offset additional costs. (p. 583)

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- 4) Walsh *et al.* (1975) focus on a much needed area for all interdisciplinary programs–the process of the interdisciplinary group experience in course planning and execution. A faculty team consisting of engineers, psychologists, sociologists, public administrators,, and representatives from other areas planned and taught a course which had as a major goal that of developing student awareness of the need for an interdisciplinary approach to selected societal problems. A two-quarter course on siting a nuclear power plant resulted; fourteen undergraduate engineering students participated.

  A systems approach was utilized for evaluation course impact. Analysis of biographical information and personality inventories revealed these students to be "adaptable in their thinking, able to cope with uncertainties, interpersonally oriented, an interested in the social sciences. The course itself was evaluated favorably by the students." (P. 1070)

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- 5) The University of Wisconsin, Green Bay (UWGB), is unique in that its entire focus is on problems of the environment (Aldrich & Kormody, 1973; Moran, *et al.*, 1974; and Weidner, 1970, 1971).

  Weis and Schwartz (1969) describe a UWGB interdisciplinary honors program in Introductory Geology and Biology which was made available to students enrolled in the regular introductory courses in either discipline. The team-teaching approach sought to develop the realization that ideas (cf., Gallant, 1972) are not the province of any discipline but rather serve to cross-pollinate all branches of knowledge. The weekly interdisciplinary seminar was utilized to provide the experience of thorough study and the opportunity for oral presentations.

  During the organizational meeting, the instructors offered a list of possible topics for papers. To illustrate integration of various materials from more than one discipline, the instructors presented the first two papers and then discussed the specifics of the content and techniques. Students were given three weeks in which to prepare papers for presentation to the class–instructors were available for conference and counsel. At the end of this period, papers were presented orally, followed by class discussion–these were taped to assist students in learning more about effective presentation techniques.

  Evaluation of the seminar indicated that the impact of the honors section was greater and more varied than had been hoped for and that the enthusiasm of the participants was especially notable. The authors felt that the students gained an intensive educational experience and were able to integrate the materials and perspectives of the two disciplines. Several students from the program who had planned previously to meet science requirements solely with biology added geology to their program.

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- 6) Ansboro (1968) discusses an experiment in interdisciplinary liberal education at New York's Manhattan College. A number of symposia were conducted by faculty from various departments around the theme of "The Hero and His Civilization." Students, mostly freshmen, were polled for their reactions, most of whom indicated that they had been highly pleased. The few negative reactions

came from students who were in academic difficulty.

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- 7) A science course for the non-science major aimed at demonstrating science-art interrelationships is described by Labianca (1975a). Focus of the course was upon atmospheric acidity and the resultant damage to art treasures. A general orientation session about the chemical aspects of the acidity in air pollution set the tone and was followed by student discussions of the effect of air pollution on works of art. The professor then made some in-sum remarks and discussion ensued. Labianca asserts: “This type of teaching technique serves to reduce, if not eliminate, the feelings of alienation which non-science majors often have for science courses,” and notes that “the experience of this teacher has been that non-science majors perform more enthusiastically and more effectively when the interdisciplinary approach is used.” (P. 190.)

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- 8) Labianca and Reeves (1975b) discuss two interdisciplinary colloquia, “Drugs and Science” and “Drugs and Literature,” both of which dealt with the phenomenon of drug synergism. *The Moonstone*, a 19th century novel, served as a text and attention was centered around the main character who, after consuming brandy and an alcohol solution containing opium, sleepwalks and steals a valuable gem. A chemist explained how this is possible (drug synergism) and pinpointed some of the chemical errors present in the novel. A re-evaluation of the novel was then requested by the literature instructor. It was concluded that:

  > The advantage of this interdisciplinary technique is that a student attains a greater depth of understanding of certain scientific information. He observes situations outside himself through the study of literature, situations to which he can apply the scientific knowledge he acquires in the science course. In the literature class the student is made more aware of the details of the literary works. He comes to realize that he must bring to literature not a blank slate but an inquisitive mind. This is the way that interdisciplinary programs should function–knowledge from one discipline providing students with information that they can use in others. (P. 67)

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- 9) In the summer of 1966, an economist, a political scientist, a sociologist, and a psychologist joined in giving an experimental introductory course in the social sciences to 53 freshman at Cornell University (Maccoby, 1967). Objectives of the course, “Why are there poor people in a rich society like the United States?”, included: 1) encouraging students to get involved in what they study, 2) promoting critical attitudes, and 3) introducing the social sciences in terms of theory–these were realized through lectures, discussions, films, and a great deal of reading.

  A variety of evaluation methods were employed (but sketchy results were presented): examination of students’ answers to the main question; selecting examples of changes in perspective; quality of individual papers; and the way in which the students began to discuss with their teachers and among themselves what they had learned.

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- 10) A biochemist collaborating with an organic chemist team-taught an interdisciplinary course in biochemistry at Hope College (Mohrig and Tooney, 1969). The two-semester course sequence included laboratory work and was offered for credit in both the Biology and Chemistry Departments

included laboratory work and was offered for credit in both the Biology and Chemistry Departments.

Over 80 percent of the 32 students enrolled during the first semester elected to take the second semester portion and it was concluded that the course was a worthwhile addition to the curriculum.

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- 11) An interdisciplinary course combining art and chemistry entitled “Structure and Color in Art Media” was offered at Maryville College (Ogren and Bunse, 1971). This course was somewhat unusual in that science was approached through art rather than vice versa (course material is outlined in a table). It began with a discussion of art media in general; later study included individual projects such as wheel-thrown pottery and the production of laboratory glassware. The authors noted that “the interest and considerable progress shown by the students in their individual projects did appear to provide a sound basis for introducing relevant chemical ideas on structure and properties.” (p. 682.)

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- 12) “Violence and Human Values” were investigated through an interdisciplinary seminar (Overholt and Schenk, 1969) in which lectures and discussions as well as leaderless group discussions were employed. A one-month recess at the end of the semester enabled students to be completely free to work on papers on selected topics.

  An evaluation similar to that by Maccoby (1967) was conducted. At the beginning of the semester and again at the end, each student was asked to write in class a short essay in response to the following: “In terms of contemporary society, what do the concepts values and violence mean to you? What relationship do you see between the two?” It was concluded that interdisciplinary courses have a high potential for offering training in thinking.

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- 13) An interdisciplinary course entitled “Engineering Man’s Environment” was offered by the Department of Civil Engineering at Northwestern University (Quon and Berry, 1972). The purpose was to help freshmen conceptualize some of the many notions frequently used in engineering, the major elements involved in engineering decisions, and the contrasts and similarities between engineering and the natural sciences. Course enrollment was 25, 32, and 37 for the years 1970-1972, and engineering majors comprised 75 percent of the students.

  Seven different lectures were given by six instructors. In addition, student projects and three term papers were required. Course grades were determined by term papers, oral presentations, and examinations. The course was “well received on the whole. The students *liked* (emphasis added) the course format....” (p. 45) The extensive reading list, presented in the report, was viewed as “highly valued” by the students. Many of the students did indicate, however, that they considered the workload too heavy and suggested assigned reading materials rather than placing the entire burden on the learner for a relatively complicated task.

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- 14) Lee Rosenthal has presented descriptions of courses in technology for non-technology students. The first one (Rosenthal, 1971) dealt with various aspects of technology (bionics, computers, lasers, environment, and ecology) taught to 20 students, all but four of whom were graduate art students. The course met weekly for three hours throughout the semester. Class meetings were often laboratories so that students could manipulate some of the technological devices. Student projects were associated with each of the course topics, and grades were based on a number of admittedly

associated with each of the course topics, and grades were based on a number of admittedly subjective criteria: 1) originality and successful solution of course problems and projects, 2) creative integration of technology, 3) quality of understanding of aspects of technology considered in the course, and 4) quality of involvement and participation in class meetings.

Feedback, as the course evaluation method, showed students' reactions were very positive and enthusiastic. Opinions about course content were dichotomized between those who felt that the technical materials should have been covered in more depth and those who considered it to be overdone. (An 18-item reference list on technology and the arts was profferred.)

Rosenthal (1974) also reviews two courses, "Aspects of Technology" and "Basic Concepts and Applications of Technology," taught at New College, and experimental college at Hofstra University. Course emphasis as upon conceptual understanding of the principles underlying technology (a syllabus and assigned text materials were presented). Topics such as energy systems, man-machine interactions, and the relationship between several technologies were chosen because they tend to arouse interest and motivation. The course stressed the learning process and the development of a sense of curiosity and wonder. No mention is made of any course evaluation except the belief that the systems viewpoint stimulated the most student interest.

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- 15) Shaw (1970) interviewed 124 graduation seniors, representing 92 percent of the total class at Justin Morrill College–a living-learning interdisciplinary endeavor–to determine how well the goals, both explicit and implicit, of the program had been perceived as being met. About 40 percent of the seniors saw significant interrelatedness between their specific courses. Most seniors, however, were critical of a lack of integration or interrelationships of the subject matter. Several seniors said departmental boundaries had not been cut–only shifted around for the benefit of the instructor, not the student.

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- 16) The course, "Chemistry and the Human Environment," for non-science majors had among its goals the demonstration of the relation of chemistry to man's culture" (Trumbore, 1975). Entering students listed five areas which they thought were the most important ones facing them as individuals or as members of society. Problem areas listed, in order of frequency, were: air/water pollution; world population problems; poverty, crime, and drugs; war and peace.

  Basic chemical concepts were introduced only on a need-to-know basis and with enough technical detail to permit understanding chemistry's role in a particular social problem. After consideration of the problems of air/water pollution, the class (approximately 60 students) was divided into three groups for each to study a remaining problem. Many faculty colleagues participated; and during the final eight weeks of course, each student prepared a paper on a selected topic. In sum:

  > The most successful group was the Poverty, Crime, and Drugs group in which political scientists doing work in a nearby ghetto area reviewed the social and economic bases of poverty. The Chairman of the Sociology Department gave, among other subjects, a survey of recent developments in the controversy over the chromosome theory of criminality. His discounting of chemical effects of air pollution on inner city residents led to a vigorous exchange of ideas on the effects of heavy metals on behavior. An M.D. toxicologist from

exchange of ideas on the effects of heavy metals on behavior. An M.D. toxicologist from State Medical Examiner's office gave a chemically oriented talk on drugs, their chemical detection, and on synergistic reactions between drugs. A high point for the students was a talk by a psychology colleague on the role of chemicals such as adrenalin and noradrenalin in aggressive animal behavior. (p. 451.)

High interest level and enthusiasm were exhibited by both students and faculty. Negative aspects included less class participation in the group sessions than anticipated and lack of time to go into as much chemical detail as the instructor detailed.

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- 17) In an interdisciplinary experiment, study of "Free Man in Technological Society," fourteen members (students and faculty) abandoned both the classroom and scheduled meetings (Vander Wilt, 1970) and lived together in "total academic immersion" in a University residence center. Methods of study during the quarter included practical and action research, discussion groups, field trips, use of resource persons, seminars, and independent studies. An open evaluation session of the entire quarter's work resulted in a number of observations and guidelines for future programs: 1) The topic was too broad for one quarter's investigation; 2) it was arduous for faculty to function in an interdisciplinary approach; 3) faculty and students found it difficult to agree on the relationship of disciplines to one another; 4) there was a need for even more required readings and experiences; and 5) this experimentation was beneficial and other innovative efforts should be pursued.

CULMINATING OBSERVATIONS

Enthusiasm for interdisciplinary courses and programs has been uniformly high; this may, however, be a novelty effect. Notable benefits claimed for such endeavors include:

1. Better integration of course materials by students from numerous disciplines; the often staggering amounts of reading and outside course work may have forced this integration.
2. Increased retention of students in their major programs (cf., Stevens and Cohen 1974) or increased numbers of them taking courses in related disciplines (Weis and Schwartz 1969).
3. Opportunities for students to chart their own courses of investigation and to pursue them actively in conjunction with faculty.

Firm conclusion as to the effectiveness and the general applicability of interdisciplinary courses are confounded by: 1) the characteristics of the students who elect to take them and 2) the faculty members who are enthusiastic and dedicated enough to develop and work, above and beyond the call of academic duty.

On the student side of the ledger, most of the reports reviewed mentioned students who are not the modal student of today. They appear to be highly motivated toward achieving their personal goals of learning about the *total* state of affairs, rather than being content with the limited perspective of individual disciplines. They are also quite academically oriented and many plan on some type of graduate study. Moreover, since several studies involved only honors students, one is forced to question how much general appeal such courses have to students *en masse*.

On the faculty side, motivation is even more intense, often bordering on the evangelical. Not to be overlooked is the fact that team-taught courses (the only courses we believe warrant the title of interdisciplinary) require each faculty participant to teach under the constant scrutiny of his peers, not merely in front of either a captive audience or fellow student enthusiasts. Regretably, the literature does not reveal what interdisciplinary faculties must do to prepare for such courses–there are a few exceptions such as the reports offered by Stevens and Cohen and by Walsh. What faculty actually do during their individual and mutual planning sessions before offering interdisciplinary courses is a vital area much in need of systematic study.

Overall there is ample evidence of the disparate notions concerning the nature of interdisciplinary education. The concept seems to be confounded with other approaches such as enrichment, honors, and independent study. Without increased clarity, it seems impossible to assess in detail, either the learning processes or the learning products.

At least two additional phenomena have been slighted: 1) selective perception and 2) faculty cultures. The former was illustrated in an interdisciplinary course taught at the University of Tennessee, Knoxville, entitled “Technology and Society” which had a large and varied undergraduate and graduate enrollment (N=218) and which involved a large number of faculty from different disciplines. Utilizing the Word Associate Test (Saeger, 1975), a sensitive technique for assessing concept acquisition and change, it was found that participants tended to see what they wanted to see. Similarly, this was noted by Gaff (1969) in the evaluation of a course at a cluster college. One way of dealing with selective perception is that of working primarily with freshmen who have a lesser degree of disciplinary loyalty or investment.

Gaff and Wilson (1971) point out that attempts to restructure higher education which rely on interdisciplinary work are not likely to succeed unless planners understand the nature of faculty cultures. The concept implies that there are fundamental differences between professors, and that the differences extend beyond subject matter into the realm of values and ideology which, in turn, are associated with fields of specialization and training.

The preponderance of the evaluation reports of recent interdisciplinary courses and programs have been of an unsystematic and subjective nature, often consisting solely of opinionated personal impressions. Surely, as scholars and educators, we should be able to do better than present testimony as evaluation which is remarkably like the testimony for patent medicines. It serves no useful purpose to label a course as interdisciplinary and then fail to collect evidence about the nature and degree of *substantive* learning by the participants.

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