DOCUMENT RESUME

ED 396 951 SE 058 679

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TITLE Interdisciplinary Science Courses for College General Education Requirements: Perspectives of Faculty at a State University.
PUB DATE 23 Apr 96
NOTE 13p.; Paper presented at the Scientific Literacy and the GER Student Mini-Conference (Iowa City, IA, 1996).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *College Science; *Faculty; *General Education; Higher Education; *Interdisciplinary Approach; Nonmajors; *Science Curriculum; Scientific Literacy; *Teacher Attitudes

ABSTRACT

Science educators have been advocating a broader role for science education--that of helping all students see the relevance of science to their own lives. Yet the only experience with post-secondary science that non-science majors get is through a couple of science courses which are part of the general education requirements (GERs) for a liberal arts undergraduate degree. This study explores perspectives of faculty at the University of Iowa with regard to the purposes of science GER courses, their success in fulfilling these purposes, and the desirability and feasibility of offering interdisciplinary courses for science GERs. Data collection included interviews with instructors of science GER courses, members of the Natural Sciences Coordinating Committee, administrators, and instructors of interdisciplinary courses. Results indicate that the faculty can be divided into two types: those who want all students, science majors and non-majors alike, to learn as much information as possible in a semester long course; and those who feel that the amount of information covered is not as important as the type of information and the approach by which the information is presented within a context of relevancy and meaningfulness. This study also indicates that faculty generally support the idea of development of scientific literacy through GER courses in science. Contains 18 references. (JRH)

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ED 396 951

INTERDISCIPLINARY SCIENCE COURSES FOR COLLEGE GENERAL EDUCATION REQUIREMENTS: PERSPECTIVES OF FACULTY AT A STATE UNIVERSITY

by

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April 23, 1996

Paper presented at the Science Education mini-conference—Scientific Literacy and the GER student—at the University of Iowa, Iowa City, Iowa.

Introduction

Recognizing the effect of science on human life in the modern age, both in an individual and societal sense, science educators have been advocating a broader role for science education—that of helping all students see the relevance of science to their own lives—than just preparing select groups of students to become scientists, engineers, or physicians (Hickman, 1982; Hurd, 1986, 1989, 1991; Kennedy, 1982; McCormack & Yager, 1989; Yager, 1984a, 1984b). Seeing the relevance and meaningfulness of science to their lives as individuals and communities is important for both science majors and non-science majors in the science-laden society of our time. It can be argued that in some ways it is even more important for non-science majors to see the relevance of science. Yet, the only experience with post-secondary science that non-science majors get is through a couple (at the most) of science courses which are part of the general education requirements (GERs) for a liberal arts undergraduate degree.

College science educators are aware of the significance of science courses for non-science majors. President of the Society fo College Science Teachers (SCST) notes:

> "We must ensure that we are providing the best possible science experience for these students who will be tomorrow's leaders" (Halyard, 1993, p. 29).

Their interest in making science meaningful to non-science majors is evident in the position statement of SCST on introductory college-level science courses (Halyard, 1993). However, a survey of science GERs at various post-secondary institutions indicates that science education requirements for non-science majors are generally declining (Magner, 1996; Purcell, 1995). This climate of declining science education requirements, and an urgent need for our students to understand the personal and societal implications of science, gives rise to the important question—How can we produce graduates who understand the relevance of science to their own lives and to the society they are a part of (Slaughter, 1993)?

Answering the above question involves re-examining the purposes of science GER courses and the extent to which most of them are successful in fulfilling these purposes. It also involves raising the question—how, if at all, should these courses be modified so that they provide students with an understanding of science that helps them cope with various consequences of the impact of science on our lives? This question, of course, presumes that the purpose of GER science courses is to provide such an understanding of science to the students.

Given the fact that most scientific issues we encounter as individuals or communities have bearings on many areas of life such as politics, economics, ethics, morality, etc., one way to make science meaningful and relevant to our students is to provide courses in which science disciplines are integrated with other areas of the curriculum. This will help students see the connections science has with other areas of inquiry and will provide a holistic picture of the role of science in our lives individually and as a society. Integration of science with other areas of the curriculum is being recommended strongly for K-12 education and is currently being tried in a number of schools (Barth, 1994). But can a similar integrative approach be used at the post-secondary level? Interdisciplinary courses as a means to making science meaningful and relevant to college students are supported in principle by SCST (Halyard, 1993). Examples of interdisciplinary, issue-oriented science courses integrating knowledge from various disciplines of science and humanities can be found at a number of post-secondary institutions (Amme & Doherty, 1992; Bouthyette, 1991-92; Leamnson, 1996; Lopez, 1996; Morgan et al, 1992-93).

In this paper I discuss a study conducted to explore perspectives of faculty at the University of Iowa with regard to the purposes of science GER courses, their success in fulfilling these purposes, and the desirability and feasibility of offering interdisciplinary courses for science GERs at a large public institution such as the University of Iowa.

Methodology

1. Design:

Following a qualitative approach, I collected data during spring 1996 through personal interviews of fifteen faculty members. These included instructors of science GER courses, members of the Natural Sciences Coordinating Committee, administrators, and instructors of some already existing interdisciplinary type courses on campus. Faculty members were invited to voluntarily participate in the study. I interviewed those who accepted the invitation. Interviews were organized around the following major questions:

> What do you think are the purposes of science GER courses or what is the role of science in liberal arts education?
>
> To what extent do you think the courses offered currently on this campus fulfil these purposes?
>
> What are your views about offering interdisciplinary science GER courses to help non-science majors see the relevance of science to their lives?

2. Data Analysis:

The interview data were analyzed using standard interview coding procedures. These involve developing coding categories which are used to sort data at different levels. The development of coding categories is usually done on the basis of the information available in the data as well as areas the researcher wants to explore. In this case, coding categories that identify each of the three main question areas represented the broadest level of categorization. Then, responses within each of the main question area were sorted into categories which would specify the respondent's specific position on the issue. The next level of categories was one which sorted each respondent's position into rationale or reasons for taking that position.

After sorting the data into coding categories, I built statements of findings based upon information from various categories.

Findings

I. Purposes of science GERs:

The question of concern here is why should a non-science major have to study science. At the University of Iowa, 7 semester hours of coursework in science is currently required to fulfil the GERs. This essentially means taking two science courses, one of which has to be a laboratory course. When asked for the purpose of requiring science in liberal arts education, faculty perspectives varied.

Many of the faculty interviewed see the purpose as exposing students to scientific methods and to expose them to a depth of knowledge in some field of science. These professors feel that "you don't really learn anything unless you go in some detail." The detail here refers to discipline-specific knowledge of science. For this reason, they favour treating "one particular area of science in reasonable depth." However, there are some faculty members who hold that the goal of science courses for non-science majors should be to go beyond discipline specific knowledge to help students develop an "increased awareness and appreciation of the natural world"; an "understanding of the cultural importance of science"; a "broad perspective of science"; an understanding of "scientific ways of thinking"; and the ability to "distinguish science from pseudo-science, from superstition, and from religion." These goals could collectively be described as the development of 'scientific literacy' among students.

II. Success of currently offered science GER courses in fulfilling the stated purposes:

Response to the question whether or not currently offered courses were fulfilling the stated purposes depended on what the perceived purpose was. Those who think the purpose is to provide students with a certain depth of discipline-specific scientific knowledge felt that most of the current courses were doing the job well. This is not surprising because most of the science courses which carry GER credit are content-oriented, discipline-specific courses.

However, those who consider development of 'scientific literacy' as the purpose, noticed that most courses are not suitably designed to fulfil that purpose. They recognize the limitations of strictly content-oriented, discipline-specific science courses in fostering attributes of 'scientific literacy'. It is important to note that faculty who think development of 'scientific literacy' is important are also making efforts to do so through their teaching strategies in spite of the constraints of their discipline-specific courses. Some of them do so by trying "to connect up with other fields so that ideas are not presented in a vacuum", and by showing "that people who discovered things and came up with ideas were influenced by society and culture of their time."

Considering the importance of the development of 'scientific literacy' and the limitations of content-oriented, discipline-specific courses in achieving this goal, some of the faculty members recommend modifying these courses or creating new ones specifically designed to achieve that goal. They feel that there should be more science GER courses designed particularly for the non-science majors, rather than "just 'watering down' a majors course and teaching it as a GER course for non-science majors." In an attempt to do so, some professors have developed courses such as 'Technology in Society' and 'Physics and Chemistry of the Environment' which are broad-based and designed to address the 'scientific literacy' objectives.

III. Interdisciplinary science courses for the non-science major:

If an important goal of science courses in liberal arts education is to develop 'scientific literacy' among students, it is critical to examine how this can be achieved through the minimal requirements of two science courses. The faculty were asked whether or not they thought it was desirable and feasible to offer interdisciplinary courses at a large public institution like the University of Iowa.

Some respondents did not think that there was even a need to consider such a proposal. To them, there does not seem to be any "reason to believe that this (interdisciplinary courses) is better than the courses offered now." The same respondents also feel that the purpose of science GERs is mainly to expose students to discipline-specific scientific knowledge. They claim that "there is not enough time for doing enough science" and are afraid that "integrating between sciences would make the courses too superficial to provide a good flavour of any science." Some of them did not approve of the idea of interdisciplinary courses on the ground that "disciplines arose since things fall into categories. If interdiscipline is important then that should be another discipline."

On the other hand, majority of the respondents were favourable to the idea in principle. The strongest response in favour of the idea was provided by a science faculty member who said, "Science ought to be integrated." However, most respondents, whether in favour or against the idea of interdisciplinary courses, identified a variety of constraints that would prevent such courses from being developed and offered in a large public institution. Some of the major constraints are as follows:

1. Faculty Related Factors

Most respondents felt that it takes a "special person" with a "special vision" and "expertise" to develop interdisciplinary courses. Further, since interdisciplinary courses would most likely involve faculty from different departments, they need to be willing to work together in teams. Doing your own stuff by yourself is much easier than working in collaboration with others. In the absence of appropriate rewards, it is difficult to get faculty motivated to do that which is more difficult. Many respondents said that faculty in different departments are people with highly specialized skills in their own field and it may be difficult to find those who feel confident and comfortable about collaborating with people from other fields to design and teach interdisciplinary courses.

2. Departmental Factors

Resources: Many respondents mentioned that departments are organized in such a way that they cannot allocate much of their limited resources on non-science majors. For instance, as one faculty member noted, "Currently the job of departments is to turn out majors. GERs are a burden on departments from the college." Departments do not seem to have enough faculty members to be able to offer GER courses specially designed for non-science majors. Financially, the departments seem to be limited too. Therefore allocating financial resources for the benefit of non-science majors is not their priority.

Apart from resources such as faculty and funds, there are problems of allocating teaching assistants. There are a limited number of teaching assistants in each department supported by the college for GER courses. For interdisciplinary courses teaching assistants may also have to be drawn from different departments but, given the limited number and funds, each department would prefer to use them for their own departmental courses rather than interdisciplinary courses.

Credits: This poses a major problem. Academic credits are given to faculty as well as departments for the courses they teach. In case of interdisciplinary courses the credits would have to be shared between faculty and between departments. This may have political implications. In case of individual faculty, credits in some departments are based upon the number of students in their courses. A minimum number of credits is needed for job retention and for promotion possibilities. Faculty may not be favourable to the idea of sharing credits when it may have negative repercussions in terms of their job security and promotion.

Due to the political implications of sharing credits, interdepartmental cooperation and coordination might be very difficult to achieve. Yet, it is critical for successfully designing and teaching interdisciplinary courses.

3. Administrative Factors

Role of Administration: Many respondents felt that administration plays a key role in providing incentives for innovative instruction in GER courses. They feel that university administration in general and administration of the college of liberal arts in particular must "pay more than lip-service to undergraduate education." Much of this means providing better rewards to faculty for teaching, and allocating more resources to departments for improving GER courses. Some faculty feel there is "an alienation between faculty and administration." As one respondent mentioned, "Administrators at all levels need to begin to see the worth of good teaching as equally important as getting research grants." It is expected that the Center for Teaching at the University of Iowa would play a key role in achieving this.

Reward Structure: This appeared to be the most crucial constraint. College faculty, like all other professionals, like to devote their time and energy on doing that which would bring professional rewards. In a large state institution like the University of Iowa, the emphasis is on research and faculty are evaluated on the basis of the amount of grant money they bring in and the extent of their published research. This leaves teaching, particularly in large enrolment GER course, to be a less rewarding function of tenure decisions. Obviously, the faculty tend to devote better part of their time and energy in research activities. From the interviews it was apparent that there are faculty who would be willing to put in time and energy into designing interdisciplinary science courses provided they were going to be duly rewarded for the effort.

Some of the rewards suggested by respondents include release time (sabbatical) to design new courses, financial rewards in terms of full merit raise, and teaching credits given as much weight as research activities in tenure decisions.

Double-counting of courses: This might have financial implications for the college of liberal arts. Currently there are some courses which carry GER credit for more than one discipline area. However, a student may have such a course counted only toward one of the possible disciplines. With true interdisciplinary courses though (specially the ones in which sciences are integrated with humanities or arts), it may be argued that the same course should count toward credits in all the possible discipline areas. Were this to be allowed, it would reduce the total number of semester hours that a student would register for in order to fulfil the GERs, thereby reducing the tuition fee s/he would pay, resulting in a net financial loss for the college. This problem, however, can easily be avoided by not changing the total number of semester hours required to graduate. Students would still have to take additional elective courses beyond fulfilling the GERs and pay tuition for those courses.

IV. Suggestions for getting around the constraints:

Apart from identifying the constraints, respondents who favoured the idea of interdisciplinary courses offered some concrete suggestions about how to get around these constraints and design interdisciplinary courses in a large public university setting. Some of these suggestions are as follows:

1. Top-down approach

Create three educational Czars—one each from Literature, Sciences and Arts. The czars ask department chairs to identify faculty who are interested in participating in a two-year experiment—first year planning and second year implementing. Make this their primary academic responsibility with all the rewards that their research work carries including full merit raise. Give this new program some space, name, money, prestige, and visibility. The faculty involved should plan and design courses in which there is room for celebrating innovative strategies on the part of both teachers and students.

2. Bottom-up approach

Faculty who are interested in improving science GER courses should get together to discuss changes. May be an electronic bulletin board could be set up for the exchange of ideas. The science faculty could invite members of other major departments such as English, History, Fine Arts, etc., to participate in this dialogue in order to find out what kind of science might they want their majors to learn in terms of its relationship to their own disciplines. The initial stimulus for this dialogue could be provided by a body such as the 'educational policy committee' which is responsible for formulating GERs and setting standards for incoming freshmen. Then a forum could be organized to discuss the nature of courses to be offered.

3. Design and course examples

Considering the actual design for interdisciplinary courses, one respondent suggested using the large group setting to identify problems that would be focused on during the course. The problems should preferably be current and of global or large scale nature. Then in small groups, instructors would work with students to help define the parameters of the problem, identify resources that would be needed, collect information, develop hypotheses, conduct research—both experimental and literature, and design solutions to the problem.

Some examples of possible interdisciplinary courses suggested by respondents in this tudy include "Sociology of the Cell", "Biomechanics of Dance", "Kinesiology of Movements", "Chemistry of 17th Century Art", "Unified Science", and "Principles of Molecular Structure and Forces of Nature".

Discussion

Given the emphasis on research and the large number of students in the liberal arts undergraduate program at large public universities, it appears rather difficult for science departments to offer GER courses designed specifically to serve the purpose of developing 'scientific literacy' among non-science major students. However, this is a goal that science GER courses must strive for in order to make college science education meaningful and relevant to our non-science major students.

This study indicates that university science teaching faculty can be divided into two types—those who want all students, science majors and non-science majors alike, to learn as much information from their specific science disciplines as possible in a semester long course, and those who feel that the amount of information covered is not as important as the type of information and the approach by which the information is presented within a context of relevancy and meaningfulness. Those who are more concerned about the amount of information do not support the idea of integrating science courses even between science disciplines, let alone between sciences and humanities or other non-science disciplines. Members of the other group are supportive of the idea of integration though many of them are apprehensive about its feasibility at a large state institution.

The following statements made by various respondents in this study reflect their general support for undergraduate science education including that of non-science major students:

> "We must not lose track of the fact that, as a public state university, we exist for the general undergraduate education of the people of Iowa."

> "We must be committed to undergraduate education."

> "We are an educational institution after all. Our first priority should be to educate the students."

However, the strongest sentiment regarding the role of science education for the non-science major is expressed in the following statement made by the same respondent who said that science ought to be integrated:

> "The real service of GER is to enlighten people about science."

This study indicates that faculty generally support the idea of development of 'scientific literacy' through GER courses in science. However, they also see that this goal is too broad to be successfully achieved through content-based, discipline-specific courses which do little more than expose students to knowledge within their particular science discipline. An interdisciplinary approach to GER science courses would be more suited to achieve the goal of 'scientific literacy' but in a large public institution such as the University of Iowa, there are constraints which restrict science departments and faculty in implementing this approach. These constraints, the ways of getting around them, and the examples and strategies for designing interdisciplinary courses which emerged through this study, all need to be given serious consideration by administrators as well as teaching faculty, and necessary action taken if we want college science education to be meaningful and relevant to our non-science major students.

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