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ABSTRACT

A collaborative project in liberal arts chemistry, involving faculty in chemistry and science education, is described. The project includes various components: an introductory test (DAST) to examine students' perceptions of scientists, a group library research exercise, oral and written presentation of the results of the library research, a presentation by a guest scientist, and a final evaluation of the experience by the students. (Author)

Putting a Human Face on Chemistry: A Project for Liberal Arts Chemistry

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ABSTRACT

A collaborative project in liberal arts chemistry, involving faculty in chemistry and science education, is described. The project includes various components: an introductory test (DAST) to examine students' perceptions of scientists, a group library research exercise, oral and written presentation of the results of the library research, a presentation by a guest scientist, and a final evaluation of the experience by the students.

INTRODUCTION

Chemistry 101, *Chemical Concepts*, at a regional university in the Pacific Northwest, is a course designed for students whose majors are in the liberal arts or non-science areas. The course serves as part of the university's general science requirement and customarily has been taught as a "traditional" course. The emphasis has been on teaching students chemical principles, including atomic and molecular structure, nomenclature, chemical reactions, stoichiometry, and additional topics as time permits. The textbook most often used is by Hill (1995). The typical enrollment is 96 students in one lecture section, with students divided into four laboratory sections.

The purpose of the project outlined in this proposal was to add an innovative component to the traditional syllabus. We felt that it would be more meaningful for students to spend time discussing what chemists did, how they thought, and some important questions in chemistry for which a general audience ought to have some appreciation. In the course of developing our program, we feel that we have a novel approach to the teaching of this type of course.

While there may be a variety of methods to address our essential objectives, we decided to build part of our curriculum around a form of a fantasy. The basic question we asked our students was, "If you were going to invite a famous person to dinner, whom would you invite?" As this was a chemistry course, we decided to limit the choice of persons to chemists, living or dead, but not fictional. From this question, we developed a structure in which we asked students to conduct research on famous chemists, to present the results of their research to the class, to select someone to invite, and to prepare interview questions for a visit by the invitee. The plan was to have one of us prepare the invited person as a theatrical character while the class prepared for the visit.

OBJECTIVES OF THE STUDY

In developing this project, we were interested in presenting a course that would be interesting to liberal arts students and that would give them a positive impression of science as a field of endeavor. We especially wished to reach an important component of the class, students who intend to graduate as prospective elementary school teachers. We felt that it was important to instill positive attitudes toward science in these pre-service teachers. Far too often, negative attitudes toward the sciences are implanted in young students' minds because their teacher projects a dislike of science (Beiswenger, Stepans, & McClurg, 1998; Crosby, 1997). Ginns and Watters (1995) state that elementary teachers should possess a sound understanding of basic science concepts to guide the identification, acceptance, self-analysis, and reformulation of students' ideas. Though not all students in Chemistry 101 are preservice teachers, we felt that all students would benefit from our innovation.

We also wished to convey that science is a human endeavor, conducted by people who are members of their society, who are influenced by their social and political environment, and who attempt to improve that environment. To that end, we intended to help our students to understand what scientists actually do, while also addressing many of the *National Science Education Standards* (1996).

A third objective was to attempt to break down some of the stereotypes that students have about science and scientists. We wanted to show that scientists are little different from other professionals. At the same time, we wished to show that people of any gender or ethnicity can be valuable contributors to science.

As a final objective, we wished to present some topics in chemistry in a form that students would see as having relevance in their daily lives. In the course of this project, we also wanted to give students practice in working in a collaborative manner, using published materials for research, and presenting their results in both an oral and a written form.

THEORETICAL UNDERPINNINGS

Based on the points developed in *Science for All Americans* (1990) and *Benchmarks for Science Literacy* (1993), we chose an approach that would address two fundamental points:

- Everybody can do science and invent things and ideas
- Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.

The 1996 publication, *National Science Education Standards*, served as a guiding document. In particular, we were interested in the four guiding principles contained in the *Standards*:

- Science is for all students
- Learning science is an active process
- School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science
- Improving science education is part of systemic education reform.

Content Standard G of the *Standards* states, in part, that students should develop an understanding of science as a human endeavor and an appreciation of the historical perspectives of science. According to *College Pathways to the Science Education Standards* (2001), university and college professors are an integral part of the science education system, as it is from their courses that many in society, including future teachers, will learn science.

DESIGN AND PROCEDURES

The textbook chosen for the course was *Chemistry in Context* (2000). This book was chosen to meet one of the class objectives, teaching some important challenges where chemistry was involved, without placing a strong emphasis on the traditional topics found in most general chemistry courses. We hoped to teach students to *appreciate* that science is important and relevant to them in their daily lives, rather than expecting them to learn to *perform* science.

We introduced our innovative component of the course and built the project around several steps, including: (1) administering the Draw-a-Scientist Test (DAST), (2) dividing the class into working groups, (3) assigning each group to develop a proposal, based on library research, on whom the class should invite, (4) oral and written presentation of each group's proposal, (5) balloting to select the invitee, (6) assigning each group to develop a set of interview questions to pose to the invitee, (7) making arrangements to have the invitee available or preparing to perform the invitee as a theatrical character, (8) hosting the invitee to eat with the class and to engage in discussion with the class, and (9) evaluation of the project and self-evaluation of the students.

At the beginning of the academic term, we wanted to see what images of scientists these students had. In order to do that, we administered the Draw-a-Scientist Test (DAST) as described by Chambers (1983) to the students on the first day of class. The prompt, "draw a scientist doing science," was given, along with a blank sheet of paper.

Student drawings included many of the common features reported in earlier studies, such as male scientists in lab coats with traditional laboratory equipment such as beakers, test tubes, and bubbling solutions. We concluded that our class portrayed scientists in a manner that was very similar to the images described in the DAST literature, although there were some interesting exceptions, as seen in Figure 1.

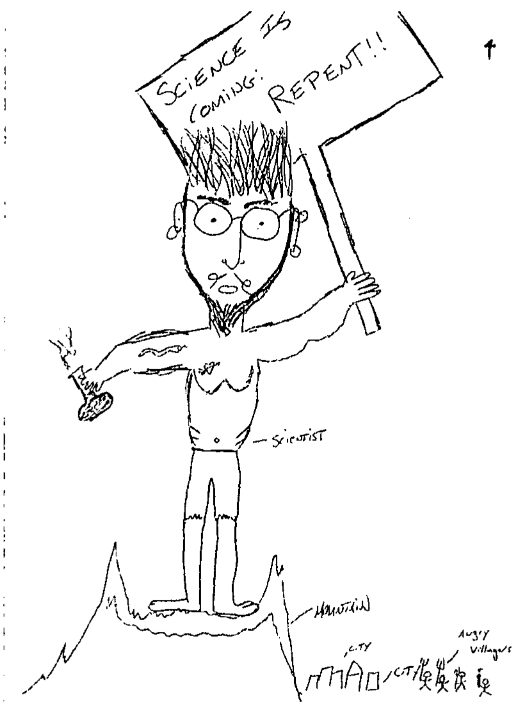

Figure 1. DAST: A quite atypical student drawing showing a dramatic representation of a scientist.

TIMETABLE AND RESULTS FOR THE GROUP ACTIVITY

Students were given three weeks to organize their research groups, to conduct library research, and to develop their proposal as an oral presentation. During the fifth week of the quarter, each group presented their nominee to the entire class. A ballot, containing the names of the nominees, was distributed and collected in class. The results of the balloting were announced. During the following five weeks, students were expected to return to the library and develop their interview questions to pose to the invitee. At the same time, the instructors were expected either to make arrangements to bring the invitee to the class or to prepare that person as a theatrical character, to be performed in costume before the class. During the eleventh week of the quarter, a buffet breakfast was served to the class (Chemistry 101 meets at 9:00 AM). It was planned that the "visitor" would then enter the class, and engage the class in a question-and-answer session for the entire class period. At the end of class, students were expected to submit their four interview questions as a written assignment. The students were also asked to complete an evaluation of their contribution to the group, and of each of their group members. Each student was also asked to complete an evaluation of the project.

Each student group met, assigned roles within their group, and proceeded to develop its proposal. No particular problems were encountered at this stage, although some students complained that they had difficulty meeting with their group. Students were given guidelines about the format of the paper, including its recommended length.

Each group made oral presentations. Since each group was given five minutes for their presentation, the emphasis was on presenting the important points about their nominee quickly and efficiently. In most cases, the students devoted considerable time and effort to these presentations, with some very advanced use of computer-aided presentation programs (such as PowerPoint™) being common. There was a gratifying degree of creativity exhibited in these presentations.

The final list of nominees presented to the class included an interesting variety of famous scientists, both men and women, including Niels Bohr, Marie Sklodowska Curie, Bill Nye "The Science Guy", and Linus Pauling (among others). The winner of the balloting was Bill Nye "The Science Guy," a television personality known for explaining science in simple terms. Because Bill Nye is familiar, especially in our region, it was clear that he could not be performed as a theatrical character; it would be necessary to invite him to meet with the class. We contacted Bill Nye's publicist and extended an invitation for breakfast with our class. However, his schedule precluded a visit.

The result of the balloting and our lack of success in attracting Bill Nye to participate left us with a dilemma. It would be too difficult to impersonate such a well-known personality. This outcome, at such a late date in the academic term, endangered the success of the project.

Finally, we decided that we would substitute for Bill Nye. On the designated date, the breakfast was served as planned, and the question-and-answer session was conducted between the students and us.

Each student group was given the assignment to prepare four interview questions that they could use during our visit. A recommended format for these questions was specified, along with an announcement that the questions would be graded on the quality of their content, originality, and writing.

The general impression was that this session went smoothly. The students participated actively in the discussion, and they did not seem to mind particularly that they did not have an opportunity to have breakfast with Bill Nye.

FINDINGS AND SIGNIFICANCE

We separated the evaluation of the project into two components. First, student performance on the project was evaluated for a grade equaling ten percent of the overall course grade. For the written proposal, oral presentation, and final interview questions, the points earned on the assignments were assigned equally to all members of each student group. In addition, the students were asked to rate themselves and the other members of their project group, based on their respective contributions to the overall result.

Each student was asked to complete an anonymous questionnaire designed to evaluate the project, its educational value, and its effect on student perceptions of chemistry and chemists. The general response to the project was favorable, as can be seen in Table 1.

Table 1. Results of Student Questionnaire

Questionnaire Statement	%Agree	%Disagree
The experience of working in a cooperative research group for this project was a positive one.	53	21
Students were assigned to the research groups in a fair and reasonable manner.	88	11
The points awarded for the project were appropriate, given the amount of work required.	75	9
The project helped me understand what scientists do.	52	21
Based on my research, I believe that science is a field that is accessible to all genders and races.	84	11
I felt that the project was ruined when our original speaker could not be present.	20	71
I was satisfied with the arrangements that were made as an alternative to the original speaker.	88	11
I would recommend this project be tried again in another Chem. 101 class, or perhaps in another 101 class in science.	64	16
After taking this Chem. 101 class, I have a better understanding of the nature of chemistry	77	11
After taking this Chem. 101 class, I feel more comfortable (or less fearful) about chemistry.	33	11
I feel more interested in science after taking this class.	45	16

CONCLUSIONS

We feel that the results of our initial attempt were very promising and we intend to continue developing it. One very positive aspect of this project was the opportunity for collaboration between a chemist from a science department, and a science educator from the College of Education. It is important to have this level of cooperation in order to promote an increased level of science content learning in prospective teachers (Beiswenger, Stepans & McClurg, 1998). Other positive components of this endeavor included the opportunities provided for student research, collaborative learning, presentation of research, and to see scientists and chemists as 'real people.'

Our own evaluation of this experiment shows us that further improvements in the manner in which students were assigned into groups are required. The assignment of individual roles within each group also needs improvement. We need to review methods of avoiding multiple presentations of the same scientist. Finally, we must pay better attention to the selection of topics for the overall course. We feel that it is less important, in this type of course, to pay rigorous attention to teaching the principles of chemistry, and it is more important to emphasize the human aspects of science and to instill an appreciation for the importance of science in our society.

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