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# Teaching with a Humanist


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This is a report about a team-taught course at San Francisco State University, and what I have learned teaching it for eleven years with, at different times, three different Professors of English. [For the record, their names were Edwin Nierenberg, Judy Breen, and David Renaker. They have not seen this paper and bear no responsibility for it.] We taught a course, titled "The Newtonian Revolution," dealing with the impact of Newtonian science on the literature and philosophy of the eighteenth century British enlightenment. A rough outline of the course follows.

| Weeks | Subject | Activity |
|---|---|---|
| 2 | Intro to 17'th century science and culture | read Burton |
| 3 | Newton's accom- plishment | read Newton "Optics" etc. Do experiment and report |
| 10 | Newton's influence | Read Locke, Pope, Swift, Franklin, Sterne, Shelley. Write term paper |

Class periods are balanced between informative lectures and discussions of the readings. Usually the only exam is a final with essays and short-answer questions. About twenty students from a large number of different majors enroll in the course each time it is offered.

This course is part of program of team-taught interdisciplinary courses at SFSU called NEXA, or the Science-Humanities Convergence Program. Begun in 1975 with a five-year grant of $850,000 from the National Endowment for the Humanities, NEXA promised a curriculum of ten team-taught courses exploring the boundaries between the sciences and the humanities, a series of public programs about contemporary issues of science and values, and a weekly staff seminar for the NEXA faculty. Public programs have included national colloquia on sociobiology and the heritage of Jacob Bronowski.

NEXA has survived 12 years, or seven years past the end of its major external funding. The campus currently supports a curriculum that has grown to sixteen team-taught courses, occassional public events are still presented, the

staff seminar is taking a sabbatical this spring after meeting weekly for twelve years, and NEXA has assisted the founding of similar programs on other California State University campuses.

The focus of NEXA has always been and remains its program of team-taught courses. But what happens when a humanist and a scientist come together in a classroom? Superficially what results is a humanities-style course about science and culture and their mutual interrelationships. The scientist explains scientific facts and practices; the humanist disucsses how these are reflected in art and history. In my course, for example, the students receive a few weeks lecture (and an exam question) about Newton's scientific accomplishment, and they perform an experiment which is as open-ended and realistic as possible. However, they don't learn to solve any science or math problems. Instead they listen, read, discuss, and write about the effect of Newtonian science on British literature much as they would in any humanities class.

I'll digress to describe the experiment that the students perform, because it is my attempt to have them do a little bit of realistic scientific research.

Students are asked to construct a pendulum and to report on the relationships between the weight of the bob, the length of the string, the period of oscillation, and the angle of oscillation. They do this experiment individually or in teams, at their choice, and they do the experiment in their own homes with equipment they construct themselves. The students are put in the position of a scientist who has only a vague question, and who must develop experiments that simultaneously sharpen the question and answer it.

Sometimes students who did well in a prior physics course get the wrong answer to the pendulum question, because they have learned that the period is independent of the angle, which it demonstrably is not. A few students are overwhelmed by the huge quantity of data they produce by measuring all possible combinations of length, weight, and angle. They never get their data organized into a demonstration of a conclusion. But most students do find the expected pattern and explain coherently how their data justifies their conclusion. Some manage to draw some graphs to accompany their tables, and a few even find the square-root law relating period to length.

To return to my main issue, what is so special about a NEXA course? What is it that distinguishes a NEXA course from a course in the history of science or intellectual history? The answer is team-teaching. I want to describe how team-teaching works and what I've learned from it.

My partner and I are both present for all class sessions, and we spend about one hour each week outside of class planning the course. We listen to each other's lectures, and we do not hesitate to interrupt with questions or even respectful disagreements. Our discussions teach

students that there may be more than one answer to a question, more than one interpretation of a poem or novel or even a scientific theory. We sometimes plan our disagreements ahead of time to demonstrate the different points of view characteristic of the sciences and the humanities. Having both of us present, seeing both of us discuss common issues, brings home to the students the different values of our disciplines and the different ways we view the world. No single instructor could model the two views we represent or make their contract so evident to the students. At least that is the claim and the justification for team teaching.

There are real differences between my partners and myself. The first difference, which appears trivial but which I think is crucial, is that humanists expect good writing on tests and homework. For them, the quality of student expression is as important as the correct answer in determining a student's mark. The sort of answers mathematicians are accustomed to receiving to homework and exam questions in calculus and other computational courses would not be accepted in a humanities course, even if the answers contained all the correct elements. Humanists expect students to demonstrate their grasp of a subject by explaining it clearly and completely.

The second difference is that the humanists seem to value and encourage opinion. Humanities faculty express opinions about books and ideas, and students are encouraged to do the same in class discussion. These discussions help students learn to rely on themselves to make informed judgements instead of looking to their instructors for an immediate verdict about their ideas.

Thirdly, humanists give more complex assignments than mathematicians do, but they engage in less direct methodological instruction. They assign several original works for students to read and interpret; mathematicians assign a single textbook specially designed for student comprehension. Humanists assign term projects; mathematicians assign a weekly list of short exercises. Even the humanists' exam questions are less direct and more open to interpretation than our own. To generalize, humanities students, compared to math students, are asked to engage in intellectually more sophisticated activities but are given less direct instruction in how to accomplish them.

Good writing, class discussion, and term projects can be adopted to mathematics classes. If mathematics is to become more humanistic, it will have to borrow from the humanities. In my classes, I use lots of writing assignments. Student homework must be written using complete sentences organized into paragraphs. This homework sometimes requires students to explain key concepts in their own words. For example, calculus students have beenasked to explain "rate of change". When students complain, "It's not fair to take off for grammar. This isn't an English

class.", I can mollify most of them by pointing out that they will have to combine mathematics with writing in their professional lives.

I also attempt class disscussion about issues where opinion is appropriate. We discuss issues in aesthetics when we have two answers to the same problem. We also discuss ethical matters when these arise, sometimes in the context of a statistics course, and sometimes when a particularly relevant article is published in the local paper. Last term my statistics class discussed the controversy about conflicting statistical studies of women marrying after age 30.

Some of my classes are assigned term projects based on open-ended problems that allow students to develop their own ideas. The problems require not cleverness but straightforward elaboration, an element often missing in math assignments. For example, linear algebra students have described an application of linear algebra, and abstract algebra students will find subgroups of GL(2,R).

Sometimes students are discomfited when faced with humanities-style assignments in a math class. They expect a sharp dichotomy between mathematics and the humanities. In a math class, they expect to learn theorems and algorithms, and to be tested on how well they have assimilated them. A humanities class is a place for discussing books and expressing their own ideas.

This expectation was brought home to me last year after I had assigned a short paper in a calculus course. I asked my students whether this paper was easier or harder to write than a paper in English composition. "Much harder," they responded. "In English, you can say anything. In math, you have to be right."

If students think that, in humanities, anything goes, they make a complementary mistake about mathematics when they believe that all methods are known and just have to be learned. Why else would we see students asking for more and more examples, hoping as they do to find every possible problem exemplified and therefore solved?

Certainly English instructors are not trying to teach their students to say just "anything", but it is not easy for them to teach the standards of rhetoric. Students resist the distinction between ideas and prejudice, between justification and mere repetition, between thinking and feeling. They sometimes seem to believe that discourse involving values or judgment has no rules at all. When studying Defoe's Moll Flanders in NEXA, students are quick to judge Moll, but they are less successful in defending their judgments by analyzing her actions or social background.

Math students are notoriously no more successful than humanities students in making logical arguments. Once in calculus, when I pointed out to a student that she defined a term one way in her first sentence and used it in the

opposite sense in the next, she responded: "Well, you can define anything any way you want!" So you can, but how can we stop students from changing their definitions in mid-argument?

As I try to overcome the limited student view of mathematics as the application of rules, I find myself in league with my humanistic colleagues who are attempting to instill standards in students. I believe we share the following four goals:

1. Students should have a clear conception in mind when they write, if not when they start at least when they finish. How often do math students successfully finish a calculation with little idea of what they have accomplished?

2. Student writing should be organized and focussed on the issue at hand, and it must be grammatically correct. Math students should write complete explanations, not incomplete notes incomprehensible to anyone who doesn't already know the answer.

3. Questionable assertions should be recognized and justified. This perhaps is more difficult for humanists to achieve than mathematicians, since students so often assume their personal prejudices are obvious universal truths, but math students too have to learn to distinguish between statements that require justification from those that are obviously correct.

4. Students must have command of all the relevant information about a question. In mathematics, that means using not just basic definitions but also new theorems and prior coursework when solving a problem.

These four common goals for mathematics and humanities education don't mean that the sciences are the same as the humanities. Manifold differences exist, and the NEXA staff seminar, after twelve years, has not yet exhausted its discussion of them. However, the differences as perceived by students are not the right ones, but rather are symptomatic of the degree to which mathematicians and humanists have failed to communicate to students that the same intellectual rigor and flexibility is required in all academic subjects. Team teaching with humanists has shown me how many goals I share with them, and it has taught me some of the ways I can try to achieve these goals in my math classes.