TEACHING STATEMENT: PATRICK BRADY

In his classic text *The Idea of a University Defined* [1], Newman outlines the role of the university in the world of his time. Education, he suggests, should instill clarity of thought and steadfastness of knowledge in the students. His notions, although couched in the language of his day, are general and serve as an excellent guide to the university educator even now. My teaching activities have long been guided by principles similar to those espoused by Newman.

The goal of my teaching activities is to enhance science education at the undergraduate and graduate levels, and to promote broader understanding of science and the scientific method by the general public. The range of activities that I have pursued in the past include development of an introductory astronomy course, design of educational posters describing gravitational-wave astronomy for the centennial meeting of the American Physical Society, and development of public lectures intended to enthuse non-specialists with research at the forefront of physics and astronomy. Over the course of my three years on the faculty at University of Wisconsin-Milwaukee, I have also developed two graduate level course on gravitational theory and experiment, and an undergraduate course on special relativity. Term papers and oral presentations were integral parts of the upper level courses. It was found that involving the students in these activities was very beneficial to them; as part of the exercise, they were expected to read a paper on science writing [2] and one on presentations [3]. These articles provide excellent suggestions to improve one's technical writing and presentation style. It very important to involve students in such activities from an early stage in their careers; after all, an essential part of most jobs is the ability to communicate information with clarity, efficiency and enthusiasm. Over the next several years, I plan to involve undergraduates in similar exercises.

My teaching experience gained by direct interaction with students has been very positive, and has lead to steady improvement in my teaching of large classes. Nevertheless, I feel that it is important to search out knowledge acquired by others through their teaching experience or direct research. I am also interested in using new technology for instruction. Web pages have provided a useful tool for organizing and disseminating information to the students efficiently. In the classroom, I use *Powerpoint*© presentations to provide a dynamic edge to lectures. Feedback from students suggests that they prefer to have copies of the slides before class; in recent years, I have circulated handouts via the web before each lecture. In this regard, it is interesting to note that some students found technological tools a little distracting when used in class, or difficult to master when used over the internet. This is indicative of the need to balance new teaching techniques and traditional methods with which the students feel comfortable and familiar.

Under the Cottrell Scholars program, I am currently developing and evaluating several novel teaching methods in my courses. As indicated above, I want the educational experience to engage students directly in both critical reasoning and presentation exercises while learning the facts of the subject.

Problem based learning (PBL) has been employed in medical schools for over three decades, and Albanese and Mitchell [4] say that "PBL has achieved some very positive outcomes." In the past, I have used PBL in small classes where it was possible to interact one-on-one with the students as they worked through the exercises. For example, in my course on special relativity, I had my class

read Einstein's original 1905 paper (translated into English). Each student was required to present a section of the paper to the class. The idea was to promote an understanding of the subject by direct contact with the original material. This was a moderately successful enterprise; the students were forced to better understand the content of the lectures in their efforts to express Einstein's original explanations in modern notation and context. This particular exercise would be improved by assigning different papers to the students in pairs.

While the use of PBL in small classes is clearly fruitful, I am trying to extend my use of the method to large introductory classes. Interest in the introductory astronomy program at UWM has been declining in recent years despite access to the planetarium and observatory. I have been working to improve the experience for the students, who are predominantly non-science majors. The goals of this astronomy course are (i) to enable students to learn about astronomy and the methods used by astronomers; and (ii) to provide an appreciation for research and the scientific method. During my first semester teaching this course, I quickly understood the difficulty with this. Students need to be engaged in a Socratic dialog if they are to truly gain a sense of scientific research. It is difficult to engage a class of 120 students on an individual basis to achieve these goals. This semester, I introduced a student learning exercise which lasted several weeks. The goal was simple: to measure the size and mass of the Earth. I first posed the question to the class in a short presentation at the beginning of a lecture, and then left it with them. The next lecture, I spent five minutes at the start of class talking to them about ideas they had and focusing on the easy measurement of the radius of the Earth. By the third lecture, they had a concrete suggestion. So, I posed the question on an assignment where I provided *data* from the proposed experiment. I was pleased to see that this engaged many of the students.

Table 1: Summary of Student Teaching Evaluations. Teaching grade is on a four point scale.

Semester	Course	Teaching grade	No. of Students
Fall 1999	Advanced Topics in Gravitation	4.00	4
Spring 2000	Special Relativity	N/A	N/A
Fall 2000	General Relativity	4.00	4
Spring 2001	Astronomy 103	2.68	120
Fall 2001	Quantum Mechanics 441	4.00	8
Spring 2002	Astronomy 103	2.88	150
Fall 2002	Quantum Mechanics 441	4.00	6
Fall 2002	Astronomy 103	3.2	211

Involvement of Undergraduates in research: The active engagement of students in class is a natural extension of my tendancy toward close involvement with students. Over the years, I have supervised a number of undergraduates in research projects. Included among these was a summer student (Mike Cai) who developed a numerical relativity code to study critical phenomena in gravitational collapse of perfect fluids, and a senior thesis student (David Farnham) who derived a first-order hyperbolic formulation of Einstein's equations. I continue this activity through the Research Experience for Undergraduates (REU) program of the NSF. In summer 2001, two stu-

dents participated in the design and building of a 296-node Beowulf computer which will be used for gravitational-wave data analysis. My involvement in the Laser Interferometer Gravitational-wave Observatory (LIGO) project affords students a marvelous opportunity to be involved in one the most exciting "big science" projects in the world today. In summer 2002, Mark Williamsen worked with me and Jolien Creighton to develop software to search for gravitational waves. In spring and summer 2003, Dennis Mackin (now a graduate student at Rice University) worked on Grid-enabling a code used to search for gravitational waves from burst sources. He was extremely successful in this exercise. In future years, I intend to actively recruit students to spend time at the LIGO sites. This sort of activity would be incredibly beneficial; students would be faced with the day-to-day issues of a large scientific experiment that is entering a phase of rapid advancement which should continue toward the end of this decade.

References

[1] J.H. Newman, "The Idea of a University Defined."

[2] K.S. Thorne, "Notes on writing a scientific paper," (unpublished, 1980).

[3] R. Geroch, "Suggestions for giving talks," (unpublished, 1973).

[4] M.A. Albanese and S. Mitchell, *Academic Medicine* 68(1), 52-58 (1993).