Research Proposal

I. Title

The title of this research proposal is Evaluating the Effectiveness of Evidence-based Teaching Strategies in BME 301: Biotechnology and World Health

II. Investigators (co-investigators)

Rebecca Richards-Kortum, Ph.D.
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Research Associate

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Research Scientist

III. Hypothesis, Research Questions, or Goals of the Project

This research project is designed to ask two questions in the context of undergraduate science and engineering education for non-majors:

(1) What types of instructional interventions in an undergraduate non-major course produce the most student engagement during class and does this engagement translate into enhanced learning?

(2) Can students more critically discuss current health events after taking this course?

IV. Background and Significance:

Historically, formal learning environments at universities have been characterized as places where talent is selected rather than developed (Bloom, 1964) and the teaching of undergraduates by researchers is undervalued (Hughes, 2002). The Howard Hughes Medical Institute (HHMI) funds successful researchers whose interest includes evidence-based teaching practices to develop projects that "enhance science education" and "maintain the vigor of biomedical science worldwide" (Hughes, 2003). As part of this program, we received a grant from HHMI to develop a new course in Biomedical Engineering to satisfy the UT Area C science requirement for liberal arts and natural science majors whose focus is **not** engineering. This course, BME 301: Biotechnology and World Health, is far from one which simply selects talent. There are no prerequisites, enrollment is open to all levels and it fulfills a requirement in math and science. It is hypothesized that this will provide a rich eclectic mix of interests, backgrounds, and levels perfect for diverse social contexts for learning. The goal of this course is to develop talent by providing tools and experiences for the non-engineering student to engage in effective discourse about health care issues and to even read the newspaper differently upon completion of the course.

According to John Bransford, editor of How People Learn: Brain, Mind, Experience, and School (2000), research in learning science has shown that learner-centered environments are ideal for making connections between the learner's prior knowledge and the construction of new knowledge. He emphasizes the value of many opportunities for formative assessment

which "provide students with opportunities to revise and improve the quality of their thinking and understanding. In fact, learning has been defined as "the process whereby knowledge is created through the transformation of experience" (Kolb, 1984). We have structured BME 301 to take advantage of this research in learning science. We have designed several types of activities which present multiple opportunities for formative assessment. These activities include (1) **interactivities**, which are structured opportunities for in-class cooperative learning, (2) **technology-enhanced homework activities**, which are web-based out-of-class learning opportunities, where student answers are used to stimulate in-class discussion and (3) **design challenges**, where students are presented with a difficult problem and asked to design, present and defend a solution to a panel of experts. Thus, we have designed a course with rich experiences that are believed to foster deep understanding of the subject matter. However, it is important to objectively evaluate whether these activities lead to enhanced student learning and which activities and contexts promote the greatest learning. We have designed two assessment strategies to assess both student engagement and student learning which rely on collection of data by videotape.

Documenting student response with videotape is based on collective research that suggests using videotape is an effective tool to monitor the "development of a skill, change of behavior, or greater self-knowledge" (Clift, 1973). Using videotape as a primary data collection tool is an established way of objectively recording the dynamics of a classroom. Bloom (2001) examined the development of conceptual understanding of density, based on student-to-student talk with children in grades 5-7. The careful analysis of the tape produced interesting insight into the "nature and dynamics of student discourse and of how teachers can help to foster and promote such discussions". It also proved invaluable for producing actual examples of student controlled discourse which exposed misconceptions. Bruce Sherrin (2001) used videotapes of undergraduates in physics classes as a basis for deriving what it "means to understand a physics equation." According to Gay (2000) one clear way to enhance validity and reduce bias is to "use verbatim accounts of observations or interviews by collecting and recording data with tape recordings…including quotes".

References:

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V. Research Methods, Design, and Proposed Statistical Analysis:

In BME 301, we propose to use videotape in two ways to monitor student learning and engagement. (1) First, each class will be taped; tapes of student response will provide an objective source of data that can be carefully studied, analyzed, and used to disseminate to a larger audience real examples of how learner-centered environments foster understanding in undergraduate settings. (2) Secondly, we will present teams of students with articles from the popular press and ask them to provide a critical analysis both prior to and after each major unit of material is covered in BME 301. Their responses will be taped and analyzed to assess the level of student learning which has been achieved. Students participating in the second activity will receive extra credit points toward their final course grade, not to exceed 5% of the total grade value.

The instrument for classroom observation to be field-tested compares four aspects of classroom interaction: instructional intervention, student engagement, cognitive activity of students, and classroom discourse. These aspects will be coded every 5 minutes consistently throughout the class and cross- referenced with the videotape. The interview protocol will assess fluency in discussing a news article. Appendix I includes the classroom observation protocol, the interview protocol, and previous content assessment instruments.

The videotaped classroom experiences will be analyzed to determine what relationships may exist between instructional intervention, student engagement, cognitive activity, classroom discourse and content mastery. The discussion interview tapes will be used to assess content mastery as an authentic assessment. This form of authentic assessment will then be compared to traditional written tests, to examine the reliability of these two forms of assessment in measuring content mastery.

VI. Human Subject Interactions

A. Sources of potential participants: Participants will be recruited from BME 301.

B. Procedures for the recruitment of the participants: Participants will be recruited by asking for volunteers in the class who are willing to participate. It will be made clear that all data collected by the research associate, Deanna Buckley, will not be shared with the professor for the course, Dr. Rebecca Richards-Kortum, until final grades are turned in. This

will ensure the ethical nature of the study where students will not fear their participation having an effect on their grade in the course.

C. Procedure for obtaining informed consent: On the first day of class, the study will be introduced to the students and written informed consent obtained for those students who will be videotaped. Any students not wishing to participate in the videotaping will be outside of the view of the taping device during regular class periods and will not participate in the discussions of newspaper articles outside of class.

D. Research Protocol. This one semester course introduces students to world health problems and technological advances in health care. The design is a new, problem-based, student-centered, interactive curriculum to be implemented in Spring 2004. It is organized around a "road map" of technological innovation that highlights issues of engineering, ethics, economics, and technology management. Through examples and activities drawn from current biomedical research, students will develop their own understanding of the need for clinical trials, the importance of ethics, and the role of technology assessment. Students will analyze world health data and describe relationships among economic and health indicators such as health expenditures, life expectancy, and infant mortality rates. Contemporary and historical situations will be examined in which critical medical decisions must be made based only on limited preclinical evidence. Students will perform open-ended assignments such as designing and presenting a clinical trial, writing a protocol to describe the trial, and writing an informed consent document. Many of these activities will be supported and extended by a new course website, now available and under development at the following address: http://www.engr.utexas.edu/bme/faculty/richards-kortum/BME301. This website contains course information, activity modules, data, references, and links for both students and instructors.

VII. Potential risks

There are no physical risks or discomforts associated with this educational research. Due to field of view limitations of the video camera a seating area is available for students who do not wish to be videotaped.

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Whether or not a student participates in the study will not change any of the learning activities or experiences associated with the class. The only treatment for participating in this research that differs for those not participating is an agreement to be videotaped. This method of data collection ensures that there is an objective record of student responses that can be analyzed later in great detail. These responses might be lost in the more subjective analysis that could be captured by simply having an observer sit in class and note student

responses in real time and is therefore essential to the success of the reliability and validity of the assessment by eliminating observer bias.

These studies will use video recordings and the cassettes will be; (a) coded so that no personally identifying information is visible on them; (b) kept in a secure place - a file cabinet in the locked co-investigator's office; (c) viewed only for research purposes by the investigator and his or her associates; (d) and may be retained for possible future research analysis. This can be done effectively with no risk to the confidentiality of the participants in the study.

As this study poses no risk, there will be no payment for physical or perceived psychological harm.

VIII. Potential benefits

Participation in this study will provide data which will permit researchers to identify learning behaviors that are positively associated with content mastery in this course while comparing various instructional techniques. This study will result in an in-depth understanding of the effects of a learner center environment and may result in the development of reliable and valid instruments which can measure learning in more effective ways than are currently used. This will improve the knowledge base for the science of learning and ultimately the knowledge disseminated from the study could improve the teaching of undergraduate curricula beyond the University of Texas at Austin.

IX Sites or agencies involved in the research project

All research will take place at the University of Texas at Austin.

X Review by another IRB

There are no other IRB reviews associated with this study.