Inquiry-based Design Experience in Engineering and Education Schools via CBT Development for Real-World Problems

Proposal co-submitted by:

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Abstract: This proposal describes a two-semester, six-hour design experience for undergraduates interested in engineering or education during which students will design, develop, implement, and assess computer-based training (CBT) modules to solve real-world problems. The problems will be provided from industry partners (the first partner will be Lucent Technologies' Microelectronics division). The students will operate in interdisciplinary teams to develop goal-based, inquiry-based, technology-rich approaches to teaching scientific concepts germane to the practice of engineering and education. In the process, engineering and education students will have the opportunity to engage in real-life behaviors that more closely mirror those exhibited by successful professionals.

TOTAL COST OF PROPOSED ACTIVITIES: $199,200
TOTAL REQUEST OF THIS PROPOSAL FROM VENTURES

YEAR 1 REQUEST	**$68,300**
YEAR 2 REQUEST	**$37,300**

DEPARTMENT CHAIRS SIGNATURES

Arup Sengupta, Chairman Civil and Environmental Engineering _____

Ed Shapiro, Chairperson of Education and Human Services _____

April 20, 1999

Proposal Description

The purpose of this proposal is to develop a two semester undergraduate course to develop computer based training (CBT) for industrial partners utilizing an integrated team of engineering and education students[1]. The design teams will design, develop, implement, and assess the computer based training modules under the direction of Dr. Horace Moo-Young (Civil and Environmental Engineering) and Dr. Stephen C. Bronack (Education). The construction of these modules will provide members of the design teams the opportunity to understand the concepts and constructs of engineering and instructional development at increasingly complex levels. Lucent Technologies has provided the first problems for the design teams to solve. The first cohort of teams will be working with subject matter experts and educational technologists at Lucent to design a series of instructional modules (informally referred to as "Semiconductors for Dummies") for the purpose of outreach and potential new-hire orientation.

Design Teams. The design teams will be comprised of undergraduate students from the College of Engineering, as well as undergraduates interested in education. The first cohort of Engineering students will be drawn from the Lehigh chapter of the National Society of Black Engineers. We anticipate an initial cohort of twelve students from this group. Engineering students who participate will use the experience as part of their course of study via the design elective required as part of their programs. Those students interested in education may apply the credits toward a potential education minor. One advanced graduate student from the College of Engineering and one from the College of Education will be supported to coordinate the activities of the design teams. A total of four design teams are proposed.

Project Benefits and Impact

This proposal will utilize the interdisciplinary teams to develop computer based training solutions for industrial partners. Figure 1 shows a potential process diagram of how these interdisciplinary teams will utilize their skills to develop the solution for the industry partners. This proposal will impact students in at least three colleges at the university—Engineering, Education, and either Arts and Sciences or Business and Economics by providing the following three impact areas: a new set of courses, new facilities to support cross-college, interdisciplinary projects, and significant expansions to the engineering and education programs. Initially, between twelve and sixteen students will be impacted in year one of the program. If this work is successful, other faculty members will be recruited to participate in the course.

During the first semester of this course, the design teams will be formulated with engineering and education students in each group. After an initial orientation to the problem from their industrial liaison, students will be provided with the primary materials such as a company training manual or book. Teams will begin production of goal-based, inquiry-based activities. The principal investigators will serve as faculty mentors for the

[1] Although we are designing the experience with engineering and education students in mind, it seems reasonable to assume that business majors—particularly those interested in Human Resources and/or IT Management—might find this a useful experience, and would be a welcome addition.

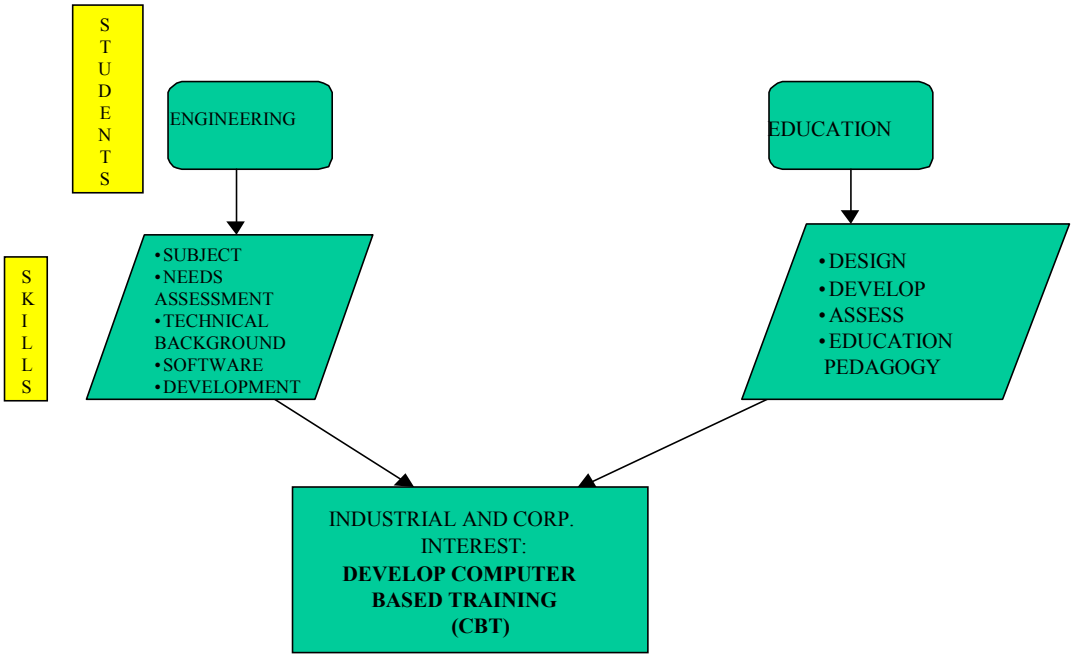

Figure 1 Process Diagram of Interdisciplinary Teams Solving Industrial Problems

design teams, providing information and guidance on such concepts as: web technology, educational and training pedagogy, and communicating engineering concepts. At the completion of the first semester, the students will produce a storyboard sketch of their solution and an initial implementation plan for their solution to the company for feedback. During the second semester, the students will develop the prototype. The prototypes will be tested and refined. At the end of the second semester, the students will provide the company with their product along with the accompanying assessment tools.

One of the major benefits of this proposal to the University and the participating colleges is the involvement of a stakeholder in the educational process. This proposal will develop a laboratory to build CBT solutions at Lehigh University. Currently, there is no laboratory on campus with these capabilities. Additionally, the program will aid the participating colleges in meeting some of the criteria set down by their respective accreditation boards and will provide an experience for the students involved that will be unique to Lehigh University. Finally, the project will extend the model of cross-college, interdisciplinary, inquiry-based activities accepted as worthwhile by Lehigh faculty and already in progress in other successful endeavors across campus.

Inquiry-based Student Learning

Applied science as practiced by professionals such as civil, electrical, chemical and mechanical engineers is firmly grounded in a process of *progressive problem solving*—that is, the process of inquiry into particular scientific problems at increasing levels of complexity. However, the typical environment in which engineering students *learn* about such problems historically has not been conducive to progressive problem solving behaviors, and students are often unable to communicate functionally what they know to others. Accreditation boards such as Accreditation Board for Engineering and

Technology (ABET) have restructured how they assess engineering and technology programs to emphasize multidisciplinary teamwork, communication skills, and life-long learning. One of the major changes in these new guidelines is the emphasis on the stakeholders (i.e., employers, alumni, students, and parents) to evaluate the program's success.

Likewise, a renewed interest in *teaching and learning for understanding* in education has sparked reform in colleges of education. Accrediting and advising organizations such as the Association for the Accreditation of Colleges of Teacher Education (AACTE) are encouraging colleges of education to produce educators who are problem-solvers, critical thinkers, and reflective practitioners. Unfortunately, education students are often expected to develop such attributes while engaged in design, development, and assessment activities divorced from any real contexts and real instructional problems.

Computer-based training is gaining greater acceptance in industry to disseminate information. Network-based technologies--when utilized properly--can foster and enhance such innovative instructional practices. Simply making technologies available is not enough, however. Instead, technology must be designed with specific problems in mind and should support meaningful collaboration and communication with others who share a real interest in solving real problems. Instructional uses of the Internet and the World-Wide Web, for example, are more likely to succeed when they address actual needs and are grounded in sound theoretical understandings. Establishing collaborative workspaces where the development of learning communities is fostered and made more concrete for students is one such use. We believe that our proposal will result in an effective instructional product that will benefit the design team members as well as the industrial partner who will utilize the computer based training product.

Project Evaluation

To evaluate the effectiveness, the investigators will engage in active measurement and assessment of the attitudes and behaviors of those involved in the project. The following questions will guide this evaluation:

- **As a result of this experience, do student participants express a more in-depth understanding of stakeholdership when compared to a similar group of students not enrolled in the course?**
- **Does the experience promote a more complex level of problem solving?**

To measure the constructs of problem solving and stakeholdership participants will be issued one of two cases (form A and B)[2] at the beginning and at the end of the semester. At the same time, a control group of students will be issued the same case. The control group will be drawn from students enrolled in senior-level engineering courses and each will be paid $50 for completion. Each group will be given a set of guiding questions and

[2] To strengthen design, two cases will be provided—a case "A" and a case "B." At the pre-intervention stage, half will analyze case A and half will analyze case B in each group. Then, at the post-intervention stage, those who analyzed case A will analyze case B, and so on. Finally, we will covary the pre-scores during analysis.

will produce an analysis of the case. The resulting analyses will be coded and judged via an established rubric by a group of experts.

	Pre	Intervention	Post
Participants (G_1)	O_a	X	O_b
	O_b		O_a
Non-Participants (G_2)	O_a		O_b
	O_b		O_a

- **Does the course result in products perceived by industry partners as reasonable and useful?**

To measure the usefulness of the deliverables—as perceived by the clients—the industry partners will be asked to complete a questionnaire designed to measure the various components of an instructional package. For example, items will be provided that are designed to measure the effectiveness of the needs analysis, the environmental analysis, the instructional activities, the knowledge base level, and the opportunities for feedback and assessment. The perceptions of the clients will serve as a useful measure for evaluating the strengths and weaknesses of the resultant products.

- **Do participants value the experience?**

It is important for student participants to view the experience as valuable, engaging, and worthwhile. To this effect, the investigators will evaluate student responses at the end of the two semesters to the following two global items as primary factors for measuring student perception of value:

- Overall, did you value your experience in this course?
- Would you recommend this course to a colleague?

Activity Timeline

Deliverable	Summer 99.2	Semester 99.3	Semester 00.1	Summer 00.2	Semester 00.3	Semester 01.1
Faculty Develop Course Material						
Develop Business Plan						
Design Storyline for CBT						
Develop StoryBoard						
Obtain Feedback from Industry Partners on Initial Design						
Develop CBT						
Test Prototype						
Develop Assessment Stategies						
Implement CBT						
Obtain Feedback						

Budget

ITEM		Year 1			Year 2		Total
	Summer	Semester 1	Semester 2	Summer	Semester 1	Semester 2	
Personnel							
Faculty Summer Salary	10,000	0		11,500	0		22,500
Graduate Assistant Salary (ed)	1,000	5,000	5,000	1,000	5,000	5,000	22,000
Graduate Assistant Salary (eng)	1,000	5,000	5,000	1,000	5,000	5,000	22,000
Control group participants		400	400		400	400	1,600
Equipment Requested							
Video Production Equipment		5,000			0	0	5,000
Web Production Equipment and Software		9,000			0	0	9,000
Laptop Computers for Groups		12,000			0	0	12,000
Video Conferencing		2,500			0	0	2,500
Scanners and Cameras		3,000			0	0	3,000
Travel		1500			1500	0	3,000
Supplies		1500			1500	0	3,000
	13,000	**44,900**	**10,400**	**13,500**	**13,400**	**10,400**	**105,600**
Cost Sharing							
Industrial Partner's Contribution		20,000			20,000		40,000
Tuition for GA from Ed School		6,200	6,200		6,200	6,200	24,800
Tuition for GA from Eng School		7,200	7,200		7,200	7,200	28,800
TOTAL COSTS:	13,000	78,300	23,800	13,500	46,800	23,800	**199,200**
		Year 1	**114,100**		**Year 2**	**81,100**	

TOTAL REQUEST OF THIS PROPOSAL FROM VENTURES

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Budget Justifications

1. One month summer salary is requested for the co-PIs in this proposal to develop the course material for the students.
2. One graduate assistant from the College of Education is requested to coordinate the educational activities of the design teams. One graduate assistant from the College of Engineering is requested to aid with the computer development of the CBT.
3. Video production Equipment--video cameras, VCR's, monitors, video capturing cards, and editing software
4. Web Production Equipment--Server, Docking stations, and software.
5. Student laptops-6 laptops will be purchased and signed out to student groups to conduct work.
6. Travel and Supplies-to obtain new industrial partners, to disseminate results, and to attract new students to the course.