

**Grant Proposal to the
University of Massachusetts Information Technology Council
Subcommittee on Academic Technology**

PROJECT TITLE: Using Remote Response Technology to Enhance and Understand Learning in a Large Classroom: An Empirical Investigation

PROJECT CATEGORY: Scholarship of Teaching and Learning

PRINCIPLE INVESTIGATOR: Amy M. Shapiro

TITLE: Professor

DEPARTMENT: Psychology Department

CAMPUS: Dartmouth

ADDRESS: 285 Old Westport Road
Psychology Department
N. Dartmouth, MA 02747-2300

EMAIL: ashapiro@umassd.edu

PHONE: (508) 910-6907

TOTAL FUNDS REQUESTED: \$13,600.00

ABSTRACT

The proposed work addresses the difficult problem of enhancing learning in large classes. It builds on an award winning implementation of technology, which demonstrated that responding to simple, in-class questions with remote response technology (RRT) raised performance on targeted test questions. The PI proposes to conduct an empirical investigation of the cognition underlying this effect and to extend the results by examining the learning effects of using RRT to promote critical thinking in large classes.

Barry Haimson, Psychology Department Chairman

Date

William Hogan, College of Art and Sciences Dean

Date

Anthony Garro, Provost

Date



Amy Shapiro, PhD
Professor of Psychology
285 Old Westport Road
North Dartmouth, MA 02747-2300
Phone: (508) 910-6907
FAX: (508) 999-9169

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To the Subcommittee on Academic Technology,

Please find the attached proposal to the Scholarship of Teaching and Learning division of the SATs recent call for proposals. The proposal is for a study of remote response technology in my PSY101 class. I have already run one such experiment and found some very encouraging results. I wish to build on that work to better understand the cognitive processing mediating students' success with the technology. I also aim to determine whether the technology can be used to foster critical thinking and active learning in very large classes.

My goal in the remainder of this letter is to tell you enough about my qualifications to convince you that I am highly qualified to undertake a project of this nature. I am a cognitive scientist and have been on the UMass Dartmouth Psychology faculty since 1994. While many senior faculty prefer to avoid introductory-level classes, I request the assignment each semester. I find it thrilling to introduce students to ideas about their own minds they have never before considered. Students respond well to my class and rate my teaching in this course as excellent each semester. I have always been interested in finding ways to enhance my students understanding and retention. I have donned a banana suit to demonstrate the importance of conformity, screamed at the top of my lungs like the confederate in Milgram's famous obedience study, and played catch with my students using salt shakers and bananas to demonstrate the role of sodium and potassium in synaptic transmission. Understandably, I became very interested in methods of enhancing learning in very large classes when my General Psychology class size moved from 60 to 210.

I still play catch and wear a banana suit, but I also began devoting some of my research time to investigating technology as a pedagogical tool. My efforts in that area won a 2007 Provost's Best Practices Award for the Recognition of Excellence in Teaching and Learning with Technology. The same year I conducted an empirical study of one technology, remote response technology (RRT), that produced some very encouraging results. That study will be presented in a poster at the 2008 University of Massachusetts Instructional Technology Conference in April. I have also begun to prepare a manuscript reporting those results, which I will submit to a peer-reviewed journal.

I do not approach the problem of technology-assisted learning solely as a concerned and seasoned instructor, however. I also approach the problem as a recognized expert in the cognitive and learning sciences, with a strong publication record in technology and learning. I earned my PhD in Cognitive Science at Brown University, where I did my dissertation on hypermedia-assisted learning. I then went on to complete a 2-year postdoctoral fellowship at the University of California at Berkeley with two leading figures in educational research, Ann Brown and Joseph Campione. Since arriving at UMass, I have published 10 book chapters or peer reviewed articles on learning with technology (I have other publications in other areas, too) and have earned a reputation as an expert in hypermedia-assisted learning. When I applied for promotion to full professor in 2005 I was required to have a number of outside reviewers provide letters on my behalf. As evidence of my reputation in the field I have provided quotes from two of these letters.

Michael Jacobson, Associate Professor, Learning Sciences Laboratory and Learning Sciences and Technology Academic Group, National Institute of Education, Nanyang Technological University, Singapor wrote:

In looking at her publications in peer reviewed journals for which she is first or sole author... 2-4 are in what would be regarded as top level prestigious journals and 5-7 are in high quality journals... Dr. Shapiro is one of the few researchers in this area today who understands the critical theoretical and research issues related to HAL and who has the experience of a seasoned cognitive science researcher to conduct important new work to advance this field... In closing, let me again stress how impressed I have been with the overall progress of research that Dr. Shapiro has been able to achieve over the years. I truly believe that without Dr. Shapiro's work, the field of HAL would be in a much less advanced state than it is.

Dr. David Jonassen, Distinguished Professor of Learning Technologies and Educational Psychology, University of Missouri wrote:

I believe that Dr. Shapiro's research has been exemplary... I have sat on P&T committees at Missouri and Penn State, where we recommended promotion to professor for academics with lesser records than hers.

My point in providing this information is to demonstrate to the Committee that I have the expertise to successfully carry out a rigorous, sound and publishable study of classroom technology. I hope I have earned your confidence. I also hope you agree that understanding and demonstrating the effectiveness of easy-to-use methods of understanding and enhancing learning in large classes is a worthwhile use of resources. Thank you for your consideration.

Sincerely,

Amy Shapiro, PhD
Professor of Psychology

Using Remote Response Technology to Enhance and Understand Learning in a Large Classroom:

An Empirical Investigation

The Problem and Its Application to the Practice of Teaching

It is widely accepted that the recommended “best practices” in teaching have moved away from didactic instruction to more active and hands-on activities aimed at developing critical thinking skills alongside knowledge acquisition. At the same time, class sizes at UMass Dartmouth have been increasing with our growing enrollment. My PSY101 course, formerly at 60 students, is now at 210. Effective teaching and learning is difficult in large classes, in general, but engaging a group of hundreds in active learning exercises is not a task most faculty are willing to attempt. The pedagogical problem addressed by this proposal is to identify and document an effective method for encouraging students in a large lecture hall to think critically, engage in active learning and retain information. Moreover, the method should be easy to use and inexpensive so that practitioners may easily apply the strategy in their own courses.

Goals of the Project

The proposed work explores remote response technology (RRT) as a solution to the problem posed above. In fall 2007 I conducted a study in my 210-student PSY101 course (after receiving an IRB waiver) to test the effectiveness of RRT. RRT allows instructors to present multiple-choice questions in any class with a digital projection system. Students are required to purchase (for \$20-35) a remote and are able to “click in” responses that are detected by a receiver, which is provided free by the RRT company (iClicker). Scores are automatically uploaded to a grade book and a bar graph of students’ responses may be displayed instantaneously to the class. Earned points on such questions can be factored into final grade calculations. For my study, I matched simple, factual RRT questions to specific items on my tests. I found that performance on control items (that had no matched RRT questions presented in class) did not increase from fall 2006 (before I began using the RRT) to fall 2007. The number of students correctly answering test items that I did pair with RRT items, however, increased from 35-50%. The data also revealed the technology to be effective for

increasing attendance.

The research I propose here has two specific goals. The first is to gain a better understanding of the cognitive mechanisms underlying the effect observed in my prior study. Specifically, there are two competing explanations for why the RRT improved students' test performance. The first possibility is that the RRT questions merely highlight important ideas for students. In other words, the effect may come about by prompting students to direct attentional resources to specific items during class and in subsequent study. The second possibility is that retrieval is acting as a source of memory encoding. Known as the *testing effect*, it has been well documented that the act of recalling a piece of information can strengthen it in memory (Roediger and Karpicke, 2006). As such, it is highly possible that asking students to retrieve a piece of information in the moments just after encoding it serves to instantiate that memory for students. If the testing effect is the source of RRT's effect on test performance, it would mean that RRT technology offers a true learning advantage rather than mere study prompts. Such a result would be important to our understanding of both learning theory and pedagogical practice.

The second goal of the proposed work is to replicate and expand the scope of the results observed in my earlier work. Specifically, I have been able to show that simple questions about facts presented in class improved performance on test questions. I want to know if presenting critical thinking questions with the RRT will allow me to "raise the bar" as an instructor by allowing me to engage students in active learning exercises and enable students to successfully tackle challenging test questions that require critical thinking.

Methodology and Assessment Plan

As in my prior study, I plan to develop specific in-class activities to target particular test items. There will be 3 types of in-class activities: RRT factual questions (the RRTf condition), RRT critical thinking questions (the RRTc condition), and non-RRT presentations designed to highlight the importance of and draw attention to the target material (the Attention condition). There will also be a Control condition. More detailed descriptions and/or sample in-class activities for each condition are provided below:

RRTf: The information is presented in class and appears on a Powerpoint slide. A RRT question is presented (e.g., *In the study discussed in class today, a group of rats was raised in cages that contained interactive toys, tunnels, other rats, etc. A control group was raised in cages with no other rats and only food and water sources. Compared with control group, those raised with stimulation: (A) were better problem solvers; (B) grew more dense dendrites; (C) grew many new neurons; (D) Both A and B.*).

RRTc: The information is presented in class and appears on a Powerpoint slide. A RRT question is asked and students are required to discuss the problem for 5 minutes with 1-5 others sitting near them prior to responding (e.g., *After intensive physical therapy, a stroke victim who lost the ability to move an arm may regain that function. When this happens, the therapy has helped the person to (A) grow new neurons that now control the arm; (B) grow new dendrites on surviving neurons that took over that function; (C) increase the amount of acetylcholine available to motor neurons needed to move the arm; (D) start using extra neurons that were not already being used to control the arm.*).

Attention: The information is presented in class and appears on a Powerpoint slide. It is highlighted with color or animation and the professor emphasizes its importance.

Control: The information is presented in class and appears on a Powerpoint slide. No special attention is drawn to the material.

Each presentation condition will be tested for its effect on factual and conceptual test question performance. For the sample material provided above, a factual test item could be *Which of the following is true about neurons? (A) We grow very few new neurons after birth; (B) Growing new dendrites allows us to acquire skills and knowledge; (C) Dendrites atrophy through disuse just like muscles; (D) all of the above.* A sample conceptual test question could be *If a newly retired relative were to ask your advice for how to “stay sharp” during his old age what would you be wise to tell him? (A) Senility is a biological process that happens to most of us and can’t be controlled, so he shouldn’t upset himself by worrying about it; (B) He should spend his new-found free time relaxing in order to live as stress-free as possible; (C) He should engage in daily activities that*

require him to learn new things and solve problems; (D) He should exercise his brain to grow new neurons.

The proposed study is structured as a 4 (presentation) x 2 (test question) within-subjects design. The targeted material and test questions will be spread across the semester. A total of 6 factual and 6 conceptual test items will be targeted in each presentation condition per semester, for a total of 48 targeted test items, answered by 420 students. Statistical analyses will be conducted for both factual and conceptual test items:

1. RRTf-paired test items and Control test items. This comparison is an attempt to replicate my fall 2007 study and provide an important validity check of my methodology.
 2. RRTf-paired test items and Attention-paired test items. This comparison will allow me to meet the first goal of the study, as it will indicate whether the RRT effects are more likely due to attention or the testing effect.
 3. RRTc-paired test items, RRTf-paired test items and Control test items. These comparisons address the second goal of the proposed work by indicating whether critical thinking exercises in large groups offer benefits to learners beyond that of simple, factual queries for both fact retention and deep comprehension.
- Analyses will be completed by converting performance scores into dichotomous data and running t-tests for analyses 1 and 2 and an ANOVA for analysis 3. A chi-square analysis is not possible because the data cells are not independent (and is less precise for analysis 3, anyway). Under these conditions, the strategy of dichotomous conversion and parametric testing is the recommended approach (Cohen and Cohen, 1975).

The study will be designed to control for random effects or variability between targeted test items. Because the grant program requires the work to be completed over a maximum of 2 semesters and is conducted in a live classroom, full counterbalancing is not possible. Instead, the 6 test questions used in each presentation condition in fall 2008 will be divided evenly among the other 3 conditions in spring 2009. In this way, I can control much of the potential error that is inherent in item differences.

On-Campus Support and Dissemination of Results

One benefit of using RRT is that the technology is easy to learn and simple to use. Moreover, I have been using the technology for over a year so I require no assistance from on-campus computing services. I gave

a copy of my proposal to Susanne Scott, Director of the UMD Center for Teaching Excellence (CTE), in early January. In her written comments she said, “The research is interesting from a theoretical perspective, highly relevant to a real problem that we are facing in the classroom, and highly publishable. The design of the experiment is rigorous. I would recommend that this study be funded.” She also assured me of CTE’s assistance should I require it. I will present the completed work at the UMD Faculty Brown Bag Series and at the UMass Instructional Technology Conference. On a national level, I intend to publish these data in a peer-reviewed journal such as *Psychological Science* or *the Journal of Scholarship of Teaching and Learning*.

Project Budget

By design, the proposed program requires no specialized equipment other than that already available in classrooms. However, a significant amount of labor is required to prepare the in-class exercises, write accompanying exam questions, and score and input data. The proposed budget is shown below:

Expense	Period	Amount
1 Month PI Summer Salary	August 2008	\$9,600
½ Time Research Assistant	September 2008-May2009	\$4,000
TOTAL		\$13,600

Project Timetable, April 2008-June 2009

April	July-Aug.	Sept.-Dec.	December 15	Jan.-May	May 20	June 1
IRB application submitted upon notification of funding	In-class exercises and test questions developed	Data collection ongoing	Fall data collection complete; interim report submitted	Data collection ongoing	Data collection and analysis completed	Final report submitted

References

Cohen, J. & Cohen, P. (1975). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates, Hillsdale, NJ.

Roediger, H. & Karpicke, J. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17, 249-255.