Faculty Innovator Grant 2014
Center for Learning and Teaching

Final Report Form

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Project Title: (10 words or less)	Critical Thinking: Beyond Theoretical Knowledge

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1. Describe the specific teaching and learning issues being addressed by the proposal.

In our initial proposed project, we intended to investigate the effectiveness of different technology applications (i.e., Clickers, WebQuest, and ResponseWare) on promoting critical thinking of undergraduate and graduate students enrolled in courses offered by the department of Communication Disorders and Special Education, the department of Engineering Technology at Old Dominion University, and the department of Physics.

2. Describe the revised specific teaching and learning issues being addressed by the proposal (if applicable):

Because of technical challenges (e.g., Clickers availability, budget expenditures) and unavailability of one of the team members (Dr. Milka Nikolic who relocated), we decided to revise the teaching and learning issues addressed in our project. In our revised project, we examined the use of a web-based polling system (i.e., Polleverywhere) in relation to critical thinking of undergraduate and graduate students enrolled in the above-mentioned departments and their perception on the effect of this technology tool in promoting learning of academic content and increasing motivation.

3. Describe the development activities involved addressing the learning or teaching issue.

The development activities for this project consisted of four phases. The first phase of the project consisted of team members meeting with a CLT staff member to discuss the project implementation and to clarify aspects related to available technology tools. During this phase, team members also attended a workshop (i.e., Turning Point: Using Clickers in the Classroom) offered by CLT. The purpose of attending the workshop was to become more familiar with the implementation of Clickers in the class setting. The second phase of the project consisted of the team members' pre-implementation meeting. The purpose of the meeting was to develop a data collection sheet that could be used across disciplines, to clarify any issues regarding project implementation, and to develop a student survey. Each team member was responsible for a specific task. For example, Dr. Chezan developed the data collection sheet, Dr. Popescu developed the student survey, and Dr. Ayala researched and presented the functions of the web-based polling system to team members. The third phase of the project consisted of the team members implementing the project in their courses. The project was implemented in two undergraduate courses in Electrical Engineering and in two graduate courses in Communication Disorders and Special Education. The format of the courses was face-to-face (one undergraduate and one graduate course) and distance learning (one

undergraduate and one graduate course). Team members communicated regularly and as needed throughout the project implementation to troubleshoot unplanned issues and to discuss progress. The fourth phase of the project consisted of the team members meeting to discuss the results and the impact of the project on students' critical thinking and motivation, challenges in project implementation, and development of future projects. Each team member collected data, and then provided this information to Dr. Chezan who analyzed the data and compiled the information into the final report. However, the overall student response in one of the undergraduate course in Electrical Engineering was extremely low (i.e., 0.01%) and thus no data for this course is included in the present report. The team is discussing the possibility of implementing the project in this specific undergraduate course during spring 2015.

4. Describe the learning outcomes attained by the project.

Critical Thinking Outcomes

Overall data collected for both undergraduate and graduate students in the field of engineering and behavior analysis suggest that students' level of performance is higher during the acquisition phase of the learning process when students are required to identify, define, or reproduce a concept taught or discussed during class sessions. For example, when assessing the acquisition of different concept (e.g., checking for formula of inductance, calculating the frequency of a sinusoid, conversion of a complex number between Cartesian and polar coordinates, or evaluating the peak-to-peak value of a sinusoid, calculating ac currents and voltages using phasor method), the mean percentage of correct responses given by undergraduate students in the electrical engineering course was 93.8% (range, 86.6% to 100%). Acquisition data suggest the same situation for graduate students enrolled in behavior analysis courses offered by the department of special education. For example, acquisition data indicate a mean percentage of correct responses of 98% (range, 87.5% to 100%) for concepts such as positive and negative reinforcement, extinction, environment, stimulus, and response class.

Generalization data for both undergraduate and graduate students suggest a lower level of performance. Generalization requires students to apply the new concepts to practical situations not discussed in class. Data indicate that the mean level of correct responding for undergraduate students on generalization tasks was 71% (range, 50% to 88%). Examples of generalization tasks include calculating the energy stored in an inductor at steady state, calculating different characteristics of sinusoids, use phasor analysis to identify elements inside a black box when ac current and voltage are given, perform conversions between Cartesian and polar coordinates when phase corrections are necessary. Generalization data indicate a similar situation for graduate students enrolled in behavior analysis courses. Specifically, the mean level of correct responding on generalization tasks was 85% (range, 75% to 98%). Examples of generalization tasks in behavior analysis include identifying the principle of behavior in a situations encountered

in a classroom, implementing an extinction procedure with a client with challenging behavior, or developing a differential reinforcement procedure to improve the functional communication of a child with autism.

Maintenance data for undergraduate students reveal a moderate to high level of performance. Specifically, the mean level of correct responding on maintenance tasks was 76% (range, 58.7% to 100%). Maintenance tasks require students to apply newly learned concepts over time without additional instruction. Maintenance data for graduate students indicate a higher level of performance. For example, the mean level of correct responding on maintenance tasks for students enrolled in behavior analysis was 85% (range, 75% to 100%).

Motivation Outcomes

Data on outcomes related to motivation consisted of number of students participating to discussions or asking questions during class sessions and student ratings on perceived motivation. The overall percentage of undergraduate students participating to discussions or asking questions during course sessions was 85% (range, 75% to 100%). It should be mentioned here that the instructor did not always waited for all the students to answer, but only for the responses to show a particular trend. The percentage of graduate students participating to discussions, asking questions, or making topic-related comments was 100% for each course session for both face-to-face and distance learning format. However, one confounding variable was the availability of participation points for students. Students reported that the web-based polling increased their motivation to participate in these courses. Specifically, data indicate that students reported a high level of motivation in both undergraduate (mean=17.08, min=9, max=21) and graduate (mean=16.53, mean=9, max=21) courses.

Student Perception on Using Polleverywhere

Data on the use of Polleverywhere consists of student ratings related to its impact on content acquisition and generalization, facilitation of discussions, collateral benefits (e.g., sharing responses with others, visual representation of results), and challenges associated with using polling. Graduate students rating (mean=15.42, min=7, max=20) on the use of Polleverywhere to promote acquisition and generalization of course content was slightly higher compared to undergraduate students rating (mean=14.45, min=7, max=20). Both undergraduate and graduate students perceived that the use of Polleverywhere during class facilitated more focused discussions (mean=3.84). Undergraduate students rating (mean=7.78, min=2, max=10) on collateral advantages associated with the use of Polleverywhere were slightly higher than graduate students rating (mean=6.73, min=2, max=10). Both undergraduate and graduate students reported that using Polleverywhere during class sessions was not associated with challenges such as difficulties using the polling, a large amount of time, or uncomfortable feelings to share response with other students during polling.

5. Describe unexpected outcomes, if any.

We did not experience any unexpected outcomes.

6. Describe the impact of the completed project on your colleagues, department, college, or community.

We believe that the results of our project may have a significant impact on our colleagues, department, college, and university for several reasons. First, the tools and strategies implemented in this project have applicability across disciplines, courses, and students. For example, we implemented the project across three different disciplines (i.e., behavior analysis, electrical engineering, and mechanical engineering), different course formats (i.e., face-to-face, and distance learning), and different students (i.e., undergraduate and graduate). Second, we developed a data collection sheet and a student survey that can be used in their current format or adapted by different instructors across disciplines to collect objective and measurable data on student learning and opinion regarding their perception of the web-based polling system. These data would allow instructors to re-teach concepts, initiate discussions, measure student progress, and adjust and revise instruction as necessary. Third, the strategies and the polling system implemented in the project are not associated with costs for instructors or students, and therefore are feasible to implement. Finally, our data have practical implications for instructors working with undergraduate and graduate students across disciplines.

One practical implication relates to addressing all stages of learning that are prerequisites for critical thinking. Instructors should allocate more time and develop tasks that address not only the acquisition of new concepts but also their application to practical situations related to students' future career. This is extremely important because the acquisition of theoretical knowledge does not necessarily guarantees the likelihood of success in applied settings. Instructors should also implement continuous assessment throughout the semester to monitor students' retention or maintenance of new concepts. The ultimate goal of teaching is to prepare our students to be successful professionals capable of using the acquired knowledge in their career.

A second practical implication refers to the use of a web-based polling system during instruction. Our data indicate the students perceived the use of a polling system as being motivating, facilitating acquisition and generalization of newly taught concepts, promoting discussions, and easy to use. In addition to the above-mentioned benefits, an instructor using a polling system has the opportunity to collect continuous data on student progress and make informed data-based decisions regarding modifications and revisions of course content and instructional strategies to increase the likelihood that the course

goals and objectives will be met.

7. Describe how the project can be a model, template, or prototype for use by other instructors.

As mentioned previously, we developed student survey (see Appendix A) to collect data on student perception regarding the impact of web-based polling system on their learning and motivation. We also developed a data collection sheet (see Appendix B) to collect data on student progress across different stages of learning including acquisition, maintenance, and generalization that are prerequisites for critical thinking. We would be happy to share these tools with instructors interested in embedding these instruments in their courses.

8. Describe the technology used to help address the issues described in the proposal.

We used a web-based polling system (i.e., Polleverywhere) to implement our project. Polleverywhere is an application that allows students in a classroom to use mobile devices (e.g., tablets, phones) to answer questions. The poll is embedded within a presentation or a web page and updates in real time displaying the results in a graphical presentation. The application allows multiple question formats including true-false, multiple choice, essay, or pictures. As a poll is displayed to students, they have the option to submit the responses by visiting a specific web site, by sending text messages, or by using Twitter. The application also allows live polls to be embedded within a blog or website.

9. Describe products, if any, that are a result of the project.

We did not develop any products in addition to the data collection sheet and student survey as a result of project implementation.

10. Describe the future plans for this project, if any.

Our future plans for this project are two-fold. First, we will continue to use Polleverywhere in our courses to better address the needs of a variety of students. Second, we initiated a research project. Specifically, we submitted a proposal and obtained approval from the Institutional Review Board (IRB) to conduct a study to examine students' perception related to the impact of Polleverywhere on their learning and motivation during courses. Dr. Popescu is the primary investigator for this project. The title of the project is "Using Polleverywhere in Engineering Classes to Increase

Students' Critical Thinking and Motivation." We will submit a proposal to the American Society for Engineering Education (ASEE). If accepted, the results of the project will be presented at the 122nd Annual Conference held in June 2015 in Seattle, WA.

11. Attach a financial report with updated Budget Plan Matrix.

Final Budget Matrix

			Source of Funds	
Budget Item (Equipment, personnel, software, etc.)	Qty.	Total Cost	Amount from FIG	Amount from Other Source
Team members	4	$2,000	$ 2,000	$ 0

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Appendix A. Student Survey

Check One: ❑ Male ❑ Female
Indicate your major: _____
Which best describes your status: ❑ Freshman; ❑ Sophomore; ❑ Junior; ❑ Senior.
What percentage of classes in this course did you attend?
____ 0-25% ____26-50% ____51-75% ____ 76-100%
How often did you answer to the questions posted via Polleverywhere:
❑ Never ❑ Sometimes ❑ Most of the time ❑ Always
If you answered "never" or "sometimes" to the previous question, please indicate the reason for now using Polleverywhere to answer questions during class session _____

Please respond to each question by checking the corresponding column.

		Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5
1	Class time passes more quickly when we use Polleverywhere.					
2	When we use Polleverywhere my participation increases in other ways too.					
3	Using Polleverywhere during class is distracting					
4	I feel uncomfortable sharing my responses via Polleverywhere					
5	Learning with Polleverywhere improves my understanding of the course content					
6	Using Polleverywhere encourages me to spend more time preparing for class					
7	Learning with Polleverywhere gives me confidence to ask more questions					
8	Using Polleverywhere encourages me to attend more classes					

9	Using Polleverywhere promotes more focused discussions during the class					
10	I would like to use Polleverywhere in other courses					
11	The response graphs provided by Polleverywhere are useful					
12	I benefit from seeing other students' response to a question					
13	Using Polleverywhere in class is too time consuming					
14	I would do better in my class without Polleverywhere					
15	I had difficulties using Polleverywhere in class					
16	I would have liked to use Polleverywhere more often in class					
17	At first learning with Polleverywhere was enjoyable but later was boring					
18	Using Polleverywhere helped me better prepare for quizzes and tests					
19	Using Polleverywhere helped me understand the concepts					
20	Using Polleverywhere helped me learn how to apply the concepts to practice					
21	Polleverywhere is easier to use when compared to clickers					

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Appendix B: Data Collection Sheet

Concept	Learning Outcome	Teaching Strategy (+ Technology Tool)	Evaluation/ Data Collected	Type of Feedback	Revisions (teaching strategy)
	Stages of Learning ❑ *Acquisition* (reproduce concept) ❑ *Fluency* (response latency) ❑ *Generalization* (novel situations) ❑ *Maintenance* (over time)	Multiple means of representation (instructor) ❑ Audio ❑ Video ❑ Print ❑ Live demonstration ❑ Lecture ❑ Activity Multiple means of engagement (student) ❑ Oral ❑ Clicker ❑ ResponseWare	❑ Multiple-choice ❑ # Q answered ❑ # Q correct ❑ Mean latency ❑ Scenario ❑ Correct outcome ❑ Incorrect outcome ❑ Problem ❑ Correct outcome ❑ Incorrect outcome	❑ Immediate ❑ Delayed	❑ Re-teach concept ❑ Additional practice ❑ Discussions

	Motivation	Multiple means of representation (instructor) ❑ Audio ❑ Video ❑ Print ❑ Live demonstration ❑ Lecture ❑ Activity Multiple means of engagement (student) ❑ Oral ❑ Clicker ❑ ResponseWare	❑ # students asking questions ❑ # of students participating in discussions ❑ # answering MC questions	❑ Immediate ❑ Delayed	❑ Change type of class activity ❑ Other (please specify)