Using Traditional LMS for Mathematics Instruction
Lessons Learned from Instructor-made Videos

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Abstract: The authors discuss the outcomes of a traditional and online mathematics course in the Mid-Atlantic United States. In the undergraduate Algebra course being investigated, the researchers used a matched pair design to determine whether technology infusion had positive effects on successful acquisition of mathematics skills. They also researched whether there was a pass/fail rate difference between the technology-enhanced class and the face-to-face class. The results indicated that there appeared to be a relationship between the instructional method and the pass/fail rate when comparing the traditional class and the technology-enhanced class.

1 INTRODUCTION

With the student dropout rates in virtual mathematics and science courses, higher than in traditional face to face courses (Thompson, 1997; Phipps and Merisotis, 1999; Smith et al., 2002), the use of traditional learning management systems is a persistent problem. Researchers have investigated student dropout rates in online education, in terms of student demographics, such as age, maturity level, gender, marital status and educational level (Morgan and Tam, 1999; Carr, 2000). Research has also suggested that the dropout rates may be lower in classes with instructors more experienced with e-learning (Carr, 2000).

Online instructors praise the new possibilities of e-learning, the increased one to one interaction with students, the deeper levels of discussion engendered by the written format, and the increased student participation (Boshier, 1990; Swan, 2001; Smith et al., 2002). Markedly missing from the celebration, however, are online mathematics instructors and students (Leventhall, 2004; Smith and Ferguson, 2004; Smith et al., 2004).

What is also limited, is a body of work that provides examples of effective pedagogical practices for e-learning in STEM fields. There are suggestions, that when there is an online component of a science course, that the use of group activities aid in focusing specific topics and increase the communication, for less participative students, in a face to face class (Seng and Mohamad, 2002).

2 BACKGROUND

2.1 Videos and Multimedia

Videos have become commonplace as online education has become more interactive and engaging (Pan et al., 2012). There have been systematic attempts to augment the online environment with this technology to address issues related to high withdrawal and drop rates as well as retention (Toppin, 2011). What makes video a resourceful teaching and learning tool is its ability to incorporate multimedia, including text, images, sound, and speech. When a learner processes and later re-processes information, each medium reinforces the others while adding to the authenticity and reality of the learning context (Brown et al., 1989). Moreover, the combination of visual and auditory messages helps foster students' dual coding of information (Bonk, 2011; Paivio, 1986) which, in turn, improve and augment students' learning process as they see concepts in action (Michelich, 2002).

Another benefit of video is learner control. In this learning environment, learners become active

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participants, able to pause, stop, skip, and rewind video sections to revisit difficult or unclear content until learners fully grasp the material presented. This process creates a greater sense of autonomy for the learner. As stated by Hartsell and Yuen (2006), video is an ideal vehicle for self-paced and self-directed learning, and learner control is the main advantage of incorporating streamed videos into distance learning courses.

2.2 Instructional Videos

Despite all the above merits, generic videos are not without stumbling blocks or challenges. Many of them are lengthy; therefore, many online learners will not be able to patiently sit, view, and remember due to the capacity of their working memory (Goldstein, 2010; Ormrod, 2008). Another disadvantage is that too often generic videos may not align well with course goals and objectives. Stacey Williams (2007) argues, given the wealth of freely available online videos, be sure to use videos that relate to course content and objectives. In light of the above mentioned disadvantages of generic videos, more and more instructors resort to so-called instructor–made videos (IMVs) that offer myriad of opportunities to enhance an online course, ranging from a general instructor introduction to discussing weekly topics, course assignments, the syllabus, to offering test reviews, answering forum questions (Rose, 2009).

The original goal for producing the IMVs by one of the authors was driven primarily by the desire to provide traditional in-class mathematics students with re-playable archives. These customized instructor-made videos are brief and concise. What makes them stand out in comparison to generic videos is their scaffolding role – addressing those specific and particular problems and concepts that are the most difficult and typically cannot be resolved independently by the students (Pan, 2012). Another merit of instructor-made videos is accommodation of students with different learning styles (Neuhauser, 2002). Visual learners need to see information. They crave pictures, graphs, and charts and would appreciate video tutorials. Auditory learners like to listen to lectures because they remember what they hear more accurately and fully than they remember what they see. Incorporating audio will accommodate their needs. The most difficult learners to address are kinesthetic and tactile learners who need to move and touch and feel what they're learning about. Mobile learning and touch screens have really opened up online video tutorials for those learners. Finally, interpersonal learners will benefit the most from customized instructor made videos that replicate the classroom setting with the sound of the instructor's familiar voice and LMS layout and background.

A quasi-experimental study was conducted in two Introductory Algebra classes at Howard University, with each class containing 45 students. Students are allowed to take more advanced mathematics courses only after they have obtained 75% or higher percentage of achievement on all tests, quizzes, and the final exam combined for this Introductory Algebra course. These combined scores constitute their final grade (given in %).

One class has been assigned to receive a traditional treatment that included only regular in-class lectures. These were 45 students in this class that served as a control group for this study. The other class, in addition to in-class instructions, had access to online instructor-made videos. These 45 students served as a treatment group for this study. Both, the control group and the treatment group met twice a week for lectures, covered the same mathematics content, and used the same textbook. The same instructor taught both classes.

3 METHOD

3.1 Research Questions

The study focused on the following research questions:

1. Does technology infusion (instructor-made videos) have positive effects on successful acquisition of math skills?
2. Is there difference in pass-fail rate between the traditional class and technology-enhanced class?

The participants of both the control group and the treatment group had to read and study the indicated pages from the math textbook prior to each in-class lecture. In-class tests, collected mandatory homework, and the final exam required proper algebraic steps for full credit. In addition to the scheduled in-class lectures and open math lab hours, participants of the treatment group were provided with the online instructor-made videos incorporated in their Blackboard class to enhance and reinforce material covered in class as well as to assist the students in making significant progress in their mathematical abilities.

3.2 Instructor-made Videos

The instructor-made videos were produced by using Camtasia™Studio Software and Wacom Bamboo Pen & Touch tablet. The Bamboo Pen & Touch tablet combines the benefits of Multi-Touch with the comfort and precision of a pen that uses the digital ink. The instructor used this tool and the Widows Journal software to write the mathematics problems as if they were on a regular whiteboard and also go over step-by-step solutions for each of these problems. All these stages of solution appeared on the instructor's computer screen. The visual and audio components of these instructional presentations were captured, produced, and edited using Camtasia™ Studio by TechSmith Company.

As the next step, all produced video tutorials were uploaded to YouTube to insure that all participants had access to these tutorials regardless of their location. Then, the uploaded videos were embedded into corresponding instructional modules in Blackboard. Each module contained approximately 4-6 videos with 2-3 problems in each video. In addition to the videos that showed step-by-step solutions to many mathematics problems, the instructor also included the major rules, procedures, and formulas related to the corresponding math topics in each module. The instructor then enabled the tracking and statistical features of the Blackboard course function to track the number of students viewing the tutorials.

3.3 Data

The final individual scores of participants in both classes were calculated by summing up the scores for all quizzes, tests, homework, and final exam that students took in this Introductory Algebra classes. The final grade was given in percent.

The descriptive analysis of the final grades was performed using the IBM SPSS Statistics 20 software. Tables 1 and 2 illustrate the results of the descriptive analysis. Since the mean score for the students in traditional face-to-face lecture class is 73.4 (with the passing minimum score of 75), we can assume that many students in this class had lower than minimum score as their final grade. The range is 53, which means that the final grades for traditional method class vary considerably; and a small part of a sample (judging by the obtained frequency distribution) had final scores that were higher than the minimum passing score of 75%.

The mean score for the students in technology-enhanced class is 81.2 (with the passing minimum score of score of 75), which is 7.8 points higher than the average final score in traditional instructional method class. Therefore, we can assume that more students in technology-enhanced class had the final score that was higher than the minimum passing score.

The second research question focused on the difference in pass-fail rate between the traditional class and technology-enhanced class. The null hypothesis was that there was no relationship between the variables (method of instruction and pass-fail rate) and that they were independent. The alternative hypothesis was that there is a relationship between the variables and that they were not independent.

4 RESULTS

With a χ^2 of 7.465 ($p < 0.05$), the researcher rejected the null hypothesis. Table 3 shows the results of the Chi-Square Test. There appears to be relationship between the class instructional method and pass/fail rate and the higher passing-the-course numbers for the treatment group is not due to the chance but were the result of the treatment (technology-enhanced instructional method). Therefore, the results of this study demonstrated that there was a difference in passing rate between the traditional class and technology-enhanced class and the freshmen students had higher passing rate for Introductory Algebra course when they use technology-infused instructional method than when they use traditional face-to-face lecture only method.

5 DISCUSSION

The current e-learning model, which is asynchronous and relies heavily on threaded discussions, does not work well for math. It is particularly challenging for the teaching and learning of mathematical problem solving (Smith and Ferguson, 2004).

In an ongoing research pilot, one of the authors is using a Blackboard discussion forum feature to stimulate mathematics problem solving and increase instructor – student and student – student interaction in a hybrid Algebra course. For individual participation on an ongoing basis, there is a collection of participation topics posted in weekly Blackboard discussions, drawn primarily from the even-numbered exercises in the course textbook. For

Table 1: Descriptive analysis for traditional instructional method class.

			Statistic	Std. Error
Traditional-final-score	Mean		73.4222	1.91129
	95% Confidence Interval for Mean	Lower Bound	69.5703	
		Upper Bound	77.2742	
	5% Trimmed Mean		73.8086	
	Median		75.0000	
	Variance		164.386	
	Std. Deviation		12.82130	
	Minimum		42.00	
	Maximum		95.00	

Table 2: Descriptive analysis for technology-enhanced instructional method class.

			Statistic	Std. Error
Technology-final-score	Mean		81.1778	1.60658
	95% Confidence Interval for Mean	Lower Bound	77.9399	
		Upper Bound	84.4156	
	5% Trimmed Mean		81.6790	
	Median		84.0000	
	Variance		116.149	
	Std. Deviation		10.77727	
	Minimum		51.00	
	Maximum		99.00	

Table 3: The results of the Chi-Square Test.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.465[a]	1	.006		
Continuity Correction[b]	6.273	1	.012		
Likelihood Ratio	7.650	1	.006		
Fisher's Exact Test				.012	.006
Linear-by-Linear Association	7.382	1	.007		
N of Valid Cases	90				

participation credit, over the fifteen weeks of the term, students are expected to solve fifteen topics (from different textbook sections). Students are free to choose any topic, complying with the discussion instructions, provided someone else has not already attempted it or "reserved" it.

For each participation topic, students earn up to 5 participation points for the accuracy of their solution. Students are given opportunities to attempt their solution more than one time. If they make an error, they get feedback from their instructor and a chance to edit their work and resubmit it. Instructor may also ask to solve an additional similar problem to make sure that students fully grasped a concept. Other students are allowed to participate in other students' discussion by providing useful clues and comments (but not full solutions or answers). One example of this student –to-student interaction was a case when one student helped other to solve a difficult problem by guiding that other student to similar problems in the textbook and recommending instructor-made videos on this topic. The goal of online participation and problem solving is to help students understand the concepts and to give them an opportunity to practice solving problems and get feedback from the instructor.

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