A PRELIMINARY COMPARISON OF GRADUATE STUDENT PERFORMANCE ON COMPUTER-MANAGED HOMEWORK VERSUS IN-CLASS PERFORMANCE: DIFFERENT TESTING FORMATS

Lynn A. Fish, Canisius College, 2001 Main Street, Buffalo, NY 14208
fishl@canisius.edu, (716)888-2642

ABSTRACT

In an operations management course, preliminary results regarding graduate student performance on computer-managed homework versus in-class testing formats are significant. Students perform better on scaffolded questions than open-ended questions. No correlation between online homework and open or partially-open question performance exists. Results have implications for computer-managed homework designers and instructors.

Keywords: Computer-managed homework, performance

LITERATURE REVIEW

It is not surprising that in today’s educational environment over 6.1 million students took at least one online course during the fall 2010 term (Allen and Seaman, 2011). Today’s educational environment is transitioning toward inclusion of more computerized technology into the classroom. Even traditional education, regarded as face-to-face (FTF) instructional delivery using paper-and-pencil assessments, continues to transition to inclusion of computerized activities. “Virtual” educational elements, such as computerized homework management systems, exist in FTF, blended, hybrid and online courses. As education continues to add evolving technology into its delivery methods, instructors need to evaluate the relevance of the various assessment activities used to evaluate student performance and enhance the learning environment. Techniques may include computerized homework, quizzes, exams, discussion board contributions, case study evaluation, individual or group projects, and other activities. Academic administrators believe that learning outcomes through online education are the same or superior to those in traditional FTF classrooms (Allen & Seaman, 2013). However, critics argue that due to intrinsic differences, online education does not replicate the learning that occurs in the traditional classroom (Bejerano, 2008). Correctly or incorrectly, educators assume that whatever information technology is implemented in a classroom, it contributes to student learning (Peng, 2009).

With respect to this research, the value of homework to the learning environment is tested. Instructors believe homework improves student’s abilities, knowledge and material retention, and educators assign homework to engage the student in the activity and encourage the student to learn (Rayburn & Rayburn, 1999). Similarly, in a recent study, students perceive homework to be valuable to the learning experience (Fish, 2013). However, this may be a misperception as studies regarding student performance and its relationship to homework are mixed. Positive relationships between homework and performance exist in an accounting course (Rayburn &
Rayburn, 1999) and a finance course (Eskey & Faley, 1988); however, no relationship exists in an introductory operations management class (Peters, Kethley & Bullington, 2002). The introductory operations management class results are particularly interesting as the researchers concluded that required homework is not significantly related to performance on a multiple choice exam (Peters et al., 2002). This prompts the question as to what about other testing formats and their associated learning. Is homework related to other testing measures? Specific to this research, is the use of computer-managed homework related to in-class student performance? Does student performance vary by testing format?

To begin this discussion, one needs to question the value of online ancillary materials, such as online homework, to student performance. Empirical research indicates that results for online homework are also mixed (Smolira, 2008). Positive results linking online homework systems to student performance exist in a finance course (Biktimirov & Klassen, 2008) and chemistry course (Arasasingham et al., 2005; Arasasingham et al., 2011). Negative or indifferent results exist in several studies (Anstine and Skidmore, 2005; Bonham, Beichner & Deardorff, 2001; Bonham, Deardorff, & Beichner, 2003; Cole & Todd, 2003; Daymont & Blaue, 2008; Horspool & Lange, 2012; Topper, 2007). Others note weak correlations between online homework and student performance on examinations (Fisher and Holme, 2000; Chamala et al., 2006). As for student overall course success, results are again mixed. One study found an insignificant relationship between web-based homework for undergraduate business statistics and overall performance (Palocsay & Stevens, 2008). Yet another study found student performance in a math course to be significantly better when using computer-generated math homework versus traditional methods (Kodippili & Senaratne, 2008). In a comparative study between four instructors using the same online homework system, only one instructor noted student improvements in exam performance through online homework while three others did not detect any significant gain (Dufresne et al., 2002). In short, there is still a lack of consensus regarding the effectiveness of online homework which highlights the need for further investigation (Arasasingham et al., 2011).

Online homework offers several benefits to the learning environment over traditional paper-and-pencil methods. These benefits include: immediate feedback which may improve student performance (Kulik & Kulik, 1986), algorithmic versus static problems which may reduce cheating (Smolira, 2008), repetition through virtually an unlimited pool of questions, early feedback on student progress which allows instructors to change methodologies or clarify concepts, requires less time for the instructor to grade, and encourages the students to think and understand the material through new and different problems (Arasasingham et al., 2011). Students appreciate homework when it is easy to use, carefully planned and integrated seamlessly with course material, and supported by the instructors (Arasasingham et al., 2011). From an instructor perspective, online homework keeps the class on task, tracks progress and allows student to work at their own pace (Arasasingham et al., 2011). Some Web-systems allow instructors to track individual student progress and pinpoint exactly where student difficulties lie (Mendicino, Razzaq and Heffernan, 2009). However, other instructors may find online instruction too time-intensive, relationally unrewarding due to the continual e-monitoring throughout the course, and feel a loss of the relational interactions with students (Bejerano, 2008). In general, if course instructors enthusiastically embrace the online approach and integrate assignments with course material, then the students embraced it as well (Arasasingham et al.,
2011). Educators cannot use a ‘one-size fits all’ approach with respect to online homework systems as not all students benefit equally from online homework system (Peng, 2009).

While the debate continues regarding the general value of homework and the value of online homework, researchers are beginning to explore the relationship between different computerized educational settings and student performance. Educational settings include the number of times students may retry problems, availability of instruction manuals and ungraded problems, seeking mastery versus limited attempts, static versus algorithmic problems, unlimited versus limited completion time, and printing abilities. With respect to multiple re-tries for homework, some researchers indicate that this encourages a ‘guess-and-check’ strategy instead of careful problem-solving (Pascarella, 2004). In an operations management class, an online homework system compared 2 attempts versus 4, and results indicate that more attempts (4) actually decreased student success (Yourstone, Kraye & Albaum, 2010). Individual differences, such as intrinsic motivation, and computer efficacy (or an individual’s confidence in ability to use the computer) are crucial factors in determining the success of an educational system, but perceived interactivity of the system is not a factor (Peng, 2009). Some students increase their homework effort not in an effort to learn, but merely to use the shortcuts to accomplish the task (Peng, 2009). With respect to performance differences between FTF and online education, academic maturity is a significant factor as freshman perform significantly worse than upperclassman (Urtel, 2009), and undergraduates performed significantly worse than graduates (Fish, 2012). Gender is not a significant factor (Urtel, 2009). However, the relationship between performance and ethnicity (white, black or Hispanic) is not significant for blacks or Hispanics; however, Caucasians tend to do better in FTF.

Therefore, much research remains to be evaluated in the online arena and the value of course-support materials (Biktimirov & Klassen, 2008). In general, online homework programs encourage learning and ‘mastery’ of material through many attempts at the problems. Given current computer software grading abilities, problems are scaffolded. By scaffolded, one part of the question will directly relate to the next, and so on. Given today’s technological capabilities, computer-generated and computer-graded, open-ended problems, whereby large, complex problems are given and the student, without prompting from one logical point of the problem to another, are not possible. (Note the instructor has the ability to input customized, static questions into the computer-managed homework system, which are graded by the instructor.) What is the relationship in student performance between computer-generated problems versus post in-class problems? Hypothetically, students who use computer-managed homework should achieve a similar score on post-homework in-class testing. Bloom’s taxonomy outlines a framework for classifying what instructors expect students to learn as a result of instruction, and then through learning goals and objectives, develop relevant testing (Krathwohl, 2002). What is the relationship between computer-managed assignments and Bloom’s taxonomy? What is the relationship between computer-managed homework and different testing formats? Since only one study studied the relationship between homework question format and in-class testing (multiple choice) (Peters et al., 2002), this is another area ripe for research, and the focus here.
METHOD

Over the course of a semester, 31 students in a graduate MBA operations management class at an AACSB-accredited university in the northeast used a computer-managed homework system as part of their course work. The intent of this research is not to evaluate the performance of the computer-managed homework system and corresponding textbook used in the course, but rather to evaluate student performance when using it versus their in-class performance. Therefore, other than to note that the specific package and textbook are very popular in the operations management arena, the specific one used is not noted.

Homework corresponded to 5% of each student’s grade and was due on the evening prior to a corresponding in-class quiz. Quizzes (where the best 8 of 10) counted for 31% of the student’s final grade. A midterm and a non-cumulative final exam were each worth 32% of the student’s final average. Quizzes, the midterm exam, and the final exam included multiple choice, short answer, interpretation and quantitative problems (with formulas provided). In developing the quizzes and the final exam, the instructor developed similar problems to the computer-managed system and tracked the corresponding student results throughout the semester.

The computer-managed homework uses 100% scaffolded, quantitative questions whereby the numbers are randomized and different between each student and each attempt. The computer program does not have the capability to grade open-ended questions at this time. For each of the 9 homework assignments, the instructor designated specific homework problems corresponding to in-class material and the impending quiz. Each homework assignment consisted of between 2 to 4 problems (potentially with sub-sections) that corresponded to similar book problems and took the student roughly 30 to 60 minutes to complete. Although the instructor can develop customized questions, this option was never used. In keeping with current best practices, additional suggested problems with solutions were available on Angel for the student to attempt. The instructor encouraged students to review these prior to attempting the computer-managed homework. For each assignment, the student had 3 tries on each problem to encourage mastery, problems were algorithmic not static, could not be printed out to work offline, and had unlimited time.

In developing the testing, three categories of in-class problems were tested, including scaffolded, partially-open, and open. Scaffolded questions encourage logical questioning and development of the problem whereby one question result is used in the next question analysis, and so on. Partially-open questions may include some scaffolding and some open-ended portion. Open questions are large, complex problems students develop without logical questioning, essentially a ‘blank sheet of paper’.

To date, the database includes student scores for 3 scaffolded questions (1 midterm and 2 quiz questions), 1 partially-open question, and 2 open questions (1 quiz and 1 midterm question). Student scores for the corresponding problems were gathered from the computer-managed grade book to complete the database. Two students who did not complete one of the computer-managed assignments were not included. The computer grade is based upon the percent correct within each problem and an internal weight developed by the computer designers.
ANALYSIS

The analysis is ongoing throughout the entire semester; however, preliminary results are interesting.

Graduate student performance on the computer homework was significantly different than in-class testing results (p=.00). Students averaged 97.21 (σ = 10.58) on the 6 corresponding computer problems, or essentially ‘mastery’ level. However, with respect to the 6 similar in-class problems, the overall average was 81.43 (σ = 11.55). Graduates averaged 85.28 (σ = 18.7) on the scaffolded test questions, but only an average of 78.375 (σ = 25.89) on the open-ended questions. Students achieved an average of 76.02 (σ = 20.01) on a partially-open question.

With respect to in-class performance, student pairwise t-test comparisons of the scaffolded versus the open questions and the scaffolded versus the partially-open questions were significant (p=.03 and p=.01 respectively). However, pairwise comparison of the partially-open and open questions was insignificant (p=.51). (Note all computer homework problems are scaffolded.)

Further analysis reveals that the correlation between the computer and the in-class testing is weak (σ=.25). However, the relationship between the computer results and the in-class scaffolded questioning is slightly more positive (σ = .41). Interestingly, there is virtually no relationship between the computer results and either partially-open or open-ended questioning (σ = -.01 and σ = -.11, respectively).

Direct comparison of computer versus in-class performance by operations management topic, indicated a significant difference in student performance for productivity (p=.00), assembly line balancing (p=.00), break-even, (p=.00) and statistical quality control (p=.00).

DISCUSSION

Preliminary results indicate a significant difference in graduate performance between computer-managed homework performance and follow-up in-class testing performance, regardless of the in-class question format. Why? Perhaps, students did not learn the mathematical tool through completing the problems on the computer-managed software. Or students may have ‘guessed-and-checked’ their way through the homework or ‘cheated’ in some manner. Another possibility is that students did not practice enough problems to perform to the expected level on the test. Or since students were able to try the problems several times on the computer, they did not adequately learn the quantitative techniques. These are just some of the potential possibilities.

With respect to the in-class question formatting, students performed considerably better on scaffolded questions in comparison to partially-open or open-ended questions. Scaffolded computer questions and in-class scaffolded questions are ‘mildly’ positive, indicating a relationship between the level of understanding a student gains through the computer problems and learning. However, since student performance is significantly different between scaffolded and open or partially-opened questions and there is no correlation between the computer problems and the partially-open or open-ended questions, questions regarding the level of
understanding that the student gains through the computer-managed homework exist. With respect to Bloom’s taxonomy, what level of learning do students exhibit through the computer-managed software versus the in-class testing formats? These preliminary results imply that computer scaffolded questions may not encourage the development of critical thinking skills toward the logical development of solutions for the more complex ‘open-ended’ questions. This is not to say that computer-managed homework systems do not have their place in the learning environment - as they certainly do! However, the current computer-managed systems may need to be further developed to allow for answering and computer grading of the open questions, that is, logical problem-solving skills that are inherent in the problem statements in scaffolded questioning. Without a doubt, technology will develop to this level in the future. What level of testing – and assurance of learning – is the instructor interested in measuring? These results support the notion that the computer-managed activities that an instructor chooses may impact the level of learning that a student attains. Stay tuned!

REFERENCES


