EXAMINING THE IMPACT OF MULTIPLE PRACTICE QUIZ ATTEMPTS ON STUDENT EXAM PERFORMANCE

Marnie C. Davis, Grand Canyon University
Lisa A. Duryee, Grand Canyon University
Alli H. Schilling, Grand Canyon University
Elizabeth A. Loar, Independent Scholar[*]
Helen G. Hammond, Grand Canyon University

ABSTRACT

Assessment of learning within the online classroom is a growing point of discussion, particularly with regard to student exam performance. In 2017, an online Organizational Behavior course offered by a large, Christian university was revised to include a change in the quizzes offered to students to prepare for each of four exams. This study examined historical exam data to determine whether changing the number of quiz attempts from one attempt to unlimited attempts significantly improved learning outcomes. To address whether unlimited exam attempts impacted exam scores, the means for exams in the Limited Quiz and Unlimited Quiz groups were compared. Second, we asked whether the change from limited to unlimited quiz attempts impacted performance specifically on the first and last exams. The results indicate that unlimited practice attempts on quizzes improved student exam performance overall. Additionally, significant improvements were found in the Unlimited Quiz group on the first and fourth exams. Based on the research and our findings, suggestions for the application of this information for faculty, curriculum developers, and administrators are discussed.

Keywords: continuous assessment and feedback, higher education, instructional technology, online assessment, online teaching, online testing, retrieval practice

INTRODUCTION

The assessment of learning in the online classroom has become a growing discussion as evidenced by the increased interest in the improvement of exam scores in recent research (Archer & Olson, 2018; Mackenzie & Ballard, 2015; Milner, Parrish, Wright, Gnarpe, & Keenan, 2015). It is valuable for faculty and administrators to understand how to best prepare students and assess learning (Plana-Erta, Moya, & Simo, 2016), resulting in greater interest from administration related to improving learning outcomes as measured by student performance on exams (Stack, 2015). Research has explored an array of factors that influence student learning; however, there is a paucity of research that directly speaks to the potential impact of unlimited attempts at practice quizzes on student exam scores.

The history of testing in the online learning environment (Shepard, 2000), retrieval practice and testing effect (Brame & Biel, 2015; Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Endres & Renkl, 2015; Karpicke & Blunt, 2011; Lee & Ahn, 2017; Roediger, Agarwal, McDaniel, & McDermott, 2011; Roediger & Butler, 2011), and cognitive tools and techniques (Snooks, 2005) have emerged as key themes related to why testing is used in the online learning

[*]This paper is dedicated to the memory of Dr. Elizabeth Ann O'Dell Loar. Whose dedication to teaching and learning touched so many.

environment. The traditional viewpoints of testing were an intertwining of curriculum theory, which focuses on specific educational objectives and precise standards; psychological theories, such as Hereditarian Theory of Intelligence, where IQ is inherent and fixed; and measurement theory, in which testing reinforces learning, and scientific measurement, which creates objective tests to measure achievement (Shepard, 2000).

Both face-to-face and online course modalities include testing as part of the course requirements and assessment. According to Jorczak and Dupuis (2014), the primary difference between classroom and online courses is the instructional environment; the instructional design of each course is virtually identical. Several studies have examined whether a difference exists in exam scores between face-to-face and online students (Daffin & Jones, 2018; Jorczak & Dupuis, 2014; Stowell & Bennett, 2010). Daffin and Jones (2018) found that students performed 10%–20% better on online exams vs. proctored exams. Jorczak and Dupuis (2014) discovered similar results and found that online students did significantly better on the exams when compared to their face-to-face counterparts. Stowell and Bennett (2010) concluded that online exams can reduce test anxiety for face-to-face students who experience high levels of negative emotions during in-class exams. The results of these studies demonstrate that online testing can be an effective assessment and learning tool, and that instructors can utilize online exams to increase teaching effectiveness and student performance.

The prevalent research on testing includes online distance education assessment (Karyotaki & Drigas, 2016; Nunes & McPherson, 2016; Okada, Scott, & Mendonça, 2015; Stack, 2015; Steadman, 2015; Yilmaz, 2017), test integrity (Brown, 2018; Lee-Post & Hapke, 2017; Miguel, 2016; Northcutt, Ho, & Chuang, 2016; Owens, 2016; Sullivan, 2016; Wielicki, 2016; Xu, Kauer, & Tupy, 2016), student perception (Chirila, 2017; Nunes & McPherson, 2016; Plana-Erta et al., 2016; Waheed, Kaur, & Qazi, 2016), and test anxiety (Davies, 2015; Evans & Culp, 2015; Neroni, Gijselaers, Kirschner, & de Groot, 2015; Sullivan, 2016). Quizzing in traditional classrooms produces a positive effect on chapter and semester exams (Roediger et al., 2011), which is not surprising considering the wealth of literature on traditional classroom formats indicating that the power of exams increases with the number of exams taken (Roediger & Karpicke, 2006). Evaluations of quizzing on exam performance using online formative assessments has yielded conflicting results because the presentation of online quizzes is critically important (Marden, Ulman, Wilson, & Velan, 2012). The only format that was positively associated with end-of-the semester examination performance for university students in Marden et al.'s (2012) study were those quizzes presented as nonthreatening learning tools, which did not count against final grades. Yilmaz (2017) noted that while the frequency of distance learning increases, restrictions include problems with evaluating student success and performance partially because of the overabundance of assessment tools, formats, and presentation options available.

Although integrity violations have been prevalent in traditional classrooms, the online classroom may be more susceptible without instructor intervention (Barnes, & Paris, 2013). Northcutt et al. (2016) identified a specific cheating strategy employed in online courses that involves assessment answers gathered by users through a "harvester" account who then subsequently submitted answers using a separate "master" account. Institutions are further challenged with adopting infallible, cost-effective integrity solutions with emerging technologies such as biometrics, surveillance systems, and predictive analytics (Lee-Post & Hapke, 2017). While student integrity remains an ongoing problem, the instances of such violations may be reduced by offering unlimited and untimed practice quizzes. By offering a low stress opportunity to take unlimited, untimed quiz attempts, student preparedness is likely to increase, subsequently reducing the potential for exam integrity issues.

The student perception of online assessment presents challenges for instructors in regard to effective, personalized, formative feedback (Plana-Erta et al., 2016). Students' perception places an importance on the usefulness of the instructor feedback in regard to classroom assessment, which increases student satisfaction significantly (Martínez-Argüelles, Plana, Hintzmann, Batalla-Busquets, & Badia, 2015). Students report a richer, motivational learning process in respect to increased instructor feedback and assessment.

While test anxiety remains a prevalent factor in

online assessment efficacy, Evans and Culp (2015) noticed that time limits do not have a significant effect on student learning, regardless of test anxiety. The decision to put time limits in place should be based on factors such as cheating or student preference rather than learning outcomes (Evans & Culp, 2015). Yang, Taylor, and Cao (2016) suggested that students who set achievement goals were more likely to employ help-seeking strategies that reduce test anxiety. The presence of unlimited, untimed practice quizzes has the potential to reduce such anxiety by providing a simulated exam experience to increase preparedness.

LITERATURE REVIEW

While online learning is rooted in assessment, a multitude of factors influence exam performance. Factors that influence exam performance in an online setting include retrieval practice (Brame & Biel, 2015; Dunlosky et al., 2013; Endres & Renkl, 2015; Karpicke & Blunt, 2011; Lee & Ahn, 2017; Roediger et al., 2011; Roediger & Butler, 2011), continuous assessment activities and feedback (Archer & Olson, 2018; Baleni, 2015; Milner et al., 2015; Paulson Gjerde, Padgett, & Skinner, 2017), and instructional technology (Bell, Simone, & Whitfield, 2016; Cohen & Sasson, 2016; Gurung, 2015; Koehler, Thompson, Correia, & Hagedorn, 2015; Mackenzie & Ballard, 2015). Each of these factors undoubtedly has the potential to impact exam performance; however, there is limited information on how the option of an unlimited attempt practice quiz could influence exam scores. Examining the impact in exam scores resulting from the option of an unlimited attempt practice quiz could lead to potential decisions being made to include unlimited attempt practice quizzes in other courses and modalities. Several areas of focus have been reviewed in the research related to testing in the online environment, including instructional technology, continuous assessment activities and feedback, and retrieval practice.

Instructional Technology

Instructional technology emerged as a key theme in the review of the literature. Themes related to instructional technology included the use of web enabled resources such as Learning Management Software (LMS), multimedia, curriculum, and publisher provided technology supplements for online course delivery (Hammond, Coplan, &

Mandernach, 2018). Technology supplements (Bell et al., 2016; Gurung, 2015; Koehler et al., 2015) and practice tests and quizzes (Bol & Hacker, 2001; Brothen & Wambach, 2001; Cohen & Sasson, 2016; Gibson, 2015; Gurung, 2003; Milner et al., 2015) have both been explored within the literature in the context of online learning and exam performance. Technology supplements can include videos (both in and out of the textbooks), online quizzes and exams, self-assessments, and case studies. These extra learning opportunities allow students to gauge their learning and view and understand course concepts in various ways while allowing faculty an opportunity to track student learning and engagement.

In three different experiments, Bell et al. (2016) found a substantial improvement in exam scores when students completed a technology-based assessment prior to completing an in-class quiz. They also found that when performance-driven students were asked to complete online study tools, they typically did. Students were given immediate feedback while using these online assessments and were provided information as to where they could find the correct information.

Koehler et al. (2015) used instructional software in a study with pretests, posttests, and surveys. This software was a type of online quiz or exam. They found that the technology increased student knowledge in a significant manner.

Gurung (2015) found that Textbook Technology Supplements (TTS) created a positive impact on student learning. The supplements included quizzes and other instructional technology tools. Student participants were required to participate in TTS activities, and after completing them, had increased exam scores.

Mackenzie and Ballard (2015) reviewed the connection between technology supplements and exam scores. They found that these supplements, including online quizzes, had the potential to increase exam scores and success in a class. Overall, technology supplements, whether created by an instructor or provided by a publisher, have the possibility to positively impact a student's exam scores.

Bol and Hacker (2001) posited that students in their research rated online practice quizzes significantly higher than other types of study materials such as outlines or summaries. However,

Brothen and Wambach (2001) were concerned that students were not using online quizzes effectively to learn material. They found that students who only take the quizzes multiple times without reading and studying course materials had poor exam scores. Their review observed that students who used a "quiz to learn" study technique were not successful overall in the course and that other techniques needed to be employed along with quizzes.

Cohen and Sasson (2016) studied the relationship between instructional design using online quizzes and final exam grades. After finding a positive correlation between quizzes and exams, they also found that students had a positive attitude toward online quizzes. Research from Gurung (2003) found that although students found online quizzes helpful, there was not a direct correlation to exam scores. Milner et al. (2015) found that students perceived online quizzes as being very effective and helpful due to their quick feedback. They compared an online quiz versus questions in PDF format. Although students enjoyed the quick feedback, they also did enjoy having a hard copy to study from.

Finally, Gibson (2015) studied the positive effects of online quizzes and found a very significant increase in exam scores for students who had access to online quizzes. Gibson (2015) found that despite challenges setting up the online quiz format, the time and effort was well worth the over 6% increase in exam scores. Although online quizzes are just one aspect of instructional technology, they are an important piece to increase student success. Instructional technology aims to increase student performance in class, and online quizzes have the potential to positively impact student learning and understanding of course content.

Continuous Assessment Activities and Feedback

Instructors evaluate progress throughout courses using various techniques referred to as continuous assessment activities. Online instruction in the context of continuous assessment activities has been explored including instant feedback within class lectures (Sabag & Kosolapov, 2012), testing effect and exam feedback (Griswold, Overson, & Benassi, 2017; Lee & Ahn, 2017; Roediger & Butler, 2011; Wojcikowski, & Kirk, 2013), quiz feedback (Baleni, 2015; Paulson Gjerde et al., 2017), immediate feedback on homework (Johnson & McKenzie, 2013), formative feedback

on assignments (Espasa & Meneses, 2010), video feedback (Denton, 2014), and multiple graded homework attempts (Archer & Olson, 2018). Continuous assessment for the purpose of this discussion will be considered as the process of assessing learning throughout a course. Feedback in the academic context is explained by Paulson Gjerde et al. (2017) as information about behavior or performance so that improvement can be made. Feedback can be used as a teachable moment that provides the "why" and "what does this mean" behind content that was misunderstood.

Sabag and Kosolapov (2012) employed a continuous assessment technique using instant feedback systems. Motivating questions were integrated throughout the lecture to advance the discussion and identify the level of student understanding and mastery. Griswold et al. (2017) found that students whose online lectures had integrated questions performed better on exams. Wojcikowski and Kirk (2013) found that students who received answers with detailed explanations on each question (right or wrong) on their exams throughout the semester performed significantly better on the final exam than those who only received the correct answer. In addition, learning outcomes are further improved when feedback is paired with practice tests or long-term retention of learning objectives (Lee & Ahn, 2017; Roediger & Butler, 2011).

Baleni (2015) ascertained that formative feedback techniques on discussion forums and exams are particularly effective for low performing students. Students in the research responded with increased commitment to learning as a result of directive feedback and improvement suggestions. Paulson Gjerde et al. (2017) explored the impact of process and outcome feedback on quiz scores. Process-oriented feedback had the greatest impact on quiz performance and was perceived to be most useful by students.

Finally, continuous assessment has been explored in the context of homework feedback. Johnson and McKenzie (2013) explored the use of a web-based learning system with required homework that provided immediate feedback and found statistically significant improvement on exam scores. Archer and Olson (2018) utilized a web-based homework management system and found a significant variance in exam scores when students

were allowed multiple attempts on their homework. Espasa and Meneses (2010) found the presence of feedback on assignments to be associated with student satisfaction and performance. Video feedback on assignments has also been identified as effective in providing clarity related to what has been done well and what are mistakes (Denton, 2014). Interestingly, students indicated interest in more of this type of feedback.

As Ken Blanchard stated, "Feedback is the breakfast of champions" (Blanchard, 2015). Feedback is key to assisting others in goal accomplishment and in the context of teaching and learning can have an impact on student success. When students receive feedback; it fills in the gap between misunderstanding and understanding. Continuous assessment partnered with feedback through the use of practice quizzes can provide yet another layer in the web of support aimed at student understanding and mastery of content.

Retrieval Practice

Testing is grounded in assessment but can also be used to improve learning. Retrieval practice or testing effect is a learning technique where one is required to retrieve information from memory in lieu of restudying the same information repeatedly (Roediger & Butler, 2011). Numerous studies have found that retrieval practice is a powerful memory aid that has resulted in improved learning outcomes especially when the learners are required to invest substantial mental effort (Brame & Biel, 2015; Dunlosky et al., 2013; Endres & Renkl, 2015; Karpicke & Blunt, 2011; Lee & Ahn, 2017; Roediger et al., 2011; Roediger & Butler, 2011).

Repeated retrieval practice or practice tests have been shown to improve students' grades. According to Snooks (2005), a review of class records over a three-year period showed that practice tests improve students' grades, and the more practice tests taken the more likely the student earned a higher grade. In the face-to-face classroom environment, students and instructors are synchronous and are all present at the same time, whereas the online classroom is asynchronous (Jorczak & Dupuis, 2014). Finding effective cognitive tools and techniques like retrieval practice through the use of unlimited attempt practice quizzes may increase the likelihood of a successful learning outcome regardless of the instructional environment.

According to Moreira, Pinto, Starling, and Jaeger (2019), research has shown that retrieval practice is more beneficial for learning than simply rereading information and certainly more beneficial than no activity. In a traditional classroom setting, active learning strategies such as concept mapping are far more effective (Moreira et al., 2019). In a distance learning environment where instructors and students interact asynchronously, active learning strategies are not possible. As such, retrieval practice in the form of unlimited attempt practice quizzes will be advantageous for online learners and may lead to improvements in exam scores.

PURPOSE

The purpose of this study was to explore exam score differences based on the presence of a practice quiz in an online Organizational Behavior course offered by a large, Christian university located in the Southwestern United States. The first research question focused on whether unlimited quiz attempts impacted students' exam scores. The second research question addressed whether unlimited quiz attempts significantly impacted performance on the first and last exams of the course. Exams 1 and 4 were advised to be of interest by content experts. Exam 1 was deemed an unfamiliar procedural assessment from the viewpoint of students whereas Exam 4 was identified as routine. Understanding the difference between practice quiz arrangements may illuminate the extension of opportunities for exam preparation tools in other courses and modalities, which may lead to improved student learning.

METHOD

Historical exam data was obtained from a course on organizational behavior for this nonequivalent groups quasi-experimental study. Changes in the delivery of practice quizzes dictated the makeup of the groups. Management sections meeting January to May 2017 were limited to one quiz attempt in preparation for exams whereas sections meeting May to October 2017 were allowed to practice quizzes, comprised of ten questions, in an unlimited fashion in preparation for exams (see Table 1). All sections completed the same four exams that tested their knowledge of the management course material. Individual student demographic information was not readily

available. Exam scores were combined for the purpose of this analysis.

Table 1. Summary of Student Groups and Dates

Dates		Limited Quiz Attempts Jan 9–May 1, 2017	Unlimited Quiz Attempt May 8–Oct. 2, 2017
		N	N
Exam	1	837	839
	2	818	812
	3	796	805
	4	770	772

RESULTS

To address the first research question that asked if unlimited quiz attempts impacted students' exam scores, the means for exams in Limited Quiz and Unlimited Quiz groups were compared (see Table 2). Participants in the Unlimited Quiz group earned higher exam scores than those in the Limited Quiz groups for each of the four exams.

Table 2. Mean Scores of Exams

		Limited Quiz Attempts	Unlimited Quiz Attempts
Exam	1	73.71%	79.89%
	2	64.35%	73.17%
	3	70.70%	76.78%
	4	70.90%	75.68%
Total Mean		69.91%	76.42%

We next asked whether unlimited quiz attempts significantly impacted performance on the first and last exams of the course. Because exam scores were not normally distributed, a nonparametric Mann-Whitney's U independent samples t-test was used to analyze if exam scores differed between students taking unlimited quiz attempts and students taking limited quiz attempts. Unlimited quiz attempts resulted in higher mean Exam 1 scores (80%) than limited quiz attempt Exam 1 scores (74%). The Mann-Whitney U test revealed a statistically significant attempt difference in Exam 1 scores, U = 262029.00, p < .001. The Cohen's d effect size associated with this difference was 0.22. Using Cohen's (1988) criteria, this finding represented a small-to-medium effect size.

Unlimited quiz attempts resulted in higher mean Exam 4 scores (76%) than limited quiz attempt Exam 4 scores (70%). The Mann-Whitney U test revealed a statistically significant attempt difference in Exam 4 scores, U = 244715.00, p < .001. The Cohen's d effect size associated with this difference was 0.15. Using Cohen's (1988) criteria, this finding represented a small effect size.

DISCUSSION

The findings of this study indicate that unlimited practice quiz attempts are a useful tool to address exam performance of online learners. However, caution must be used in generalizing the statistical significance of the results to practical implications. Although large group differences were found between students who engaged in unlimited versus limited quiz attempts, it would be beneficial to conduct research on the relationships between specific cohorts to fully understand the benefits of quiz attempts on exam performance. Numerous factors influence student learning outcomes, including individual differences, motivation, academic abilities, and varied learning approaches. Student engagement, impacted by individual preference, must also be taken into consideration as it relates to the impact on quiz effectiveness (Milner et al., 2015).

Our findings contribute to the literature on immediate feedback, which is a vital aspect of deliberate practice (Archer & Olson, 2018). Participants in the current research received answers to practice quizzes after each attempt. Due to the fact that practice quizzes are autograded in the LMS, students receive immediate feedback without increasing instructional workload. It is possible that deliberate retrieval practice can be beneficial through the use of multiple practice attempts when partnered with immediate feedback that is of both high quality and good quantity. Student feedback from research conducted by Milner et al. (2015) corroborates this line of thinking and indicates the importance of detailed feedback explanations. Another consideration in regard to deliberate practice and multiple attempts is the potential for guessing behaviors that may result in minimal improvement in exam scores.

As with any study, certain limitations of our design exist because we compared exam scores of independent samples at one point in time. We suspect our results could generalize to other undergraduate classes, but more research is needed. It would be beneficial to conduct research that is

focused on specific cohorts. Further exploratory variations such as work experience, student GPA, program of study, subsequent course retakes after failed attempts, or course delivery variations in regard to modality could also be examined. The gathering of student feedback regarding the presence of the practice quiz itself could also be assessed. Milner et al. (2015) discussed the level of engagement with given learning tools based on student perceptions and noted that a tool is only helpful if used. Dependent variables such as course satisfaction, creative learning, learner confidence in study ability, and individual study behaviors also provide further options for exploration.

In regard to multiple attempt practice quizzes, an experimental longitudinal study could provide data regarding the total number of attempts completed as well as the total time spent on practice quiz attempts in relation to subsequent exam scores. This may provide further understanding of the impact on exam scores based on the presence and use of practice quizzes, and it could shed light on how each student set may further benefit from the practice quiz as a learning tool. Researchers could compare group differences based on the presentation timing of practice quizzes, access variations, or number of attempts allowed. Finally, the potential exists for research to determine if the presence of practice quizzes results in a difference in exam scores with the same student population. In a course with four exams, for example, the same student population could be tested by varying the administration of practice quizzes by administering the first two exams with no practice quiz and subsequently allowing unlimited quiz attempts prior to the final two exams.

Based on the research and our findings, recommendations for the use of practice quizzes are applicable to faculty, curriculum developers, and administrators. The presence of multiple attempts on practice quizzes can have a positive impact on exam scores. We recommend teachers add this evaluation tool to their curriculum when possible. This allows students to gauge their learning prior to taking the exam while limiting the time demands on the instructor.

Curriculum developers responsible for creating content should consider adding practice quizzes as a learning tool to increase continuity in the student learning experience. Incidentally, student perception of learning has the potential to increase with the presence of practice quizzes, which may consequently improve exam scores as well. Finally, administrators may find practical applications for introducing practice quizzes across student populations, modality, and grade levels to increase the continuity of learning outcomes and student success while still allowing creative freedom in regard to individual teaching styles.

REFERENCES

Archer, K. K., & Olson, M. (2018). Practice. Practice. Practice. Do homework management systems work? International Journal for the Scholarship of Teaching and Learning, 12(2), Article 12. doi:10.20429/ijsotl.2018.120212

Baleni, Z. G. (2015). Online formative assessment in higher education: Its pros and cons. Electronic Journal of E-Learning, 13(4), 228–236. Retrieved from www.ejel.org/issue/download.html?idArticle=433

Barnes, C., & Paris, B. L. (2013). An analysis of academic integrity techniques used in online courses at a Southern university. Proceedings for the Northeast Region Decision Sciences Institute (NEDSI) (pp. 929–937).

Bell, M. C., Simone, P. M., & Whitfield, L. C. (2016). Evaluation of "out-of-the-box" textbook technology supplements on student learning. Scholarship of Teaching and Learning in Psychology, 2(2), 112–124. doi:10.1037/stl0000057

Blanchard, K. (2015). Feedback is the breakfast of champions [Web log post]. How we lead: Conversations on leadership with Ken Blanchard. Retrieved from https://howwelead.org/2015/01/07/feedback-is-the-breakfast-of-champions-2/

Bol, L., & Hacker, D. J. (2001). A comparison of the effects of practice tests and traditional review on performance and calibration. Journal of Experimental Education, 69(2), 133–151. doi:10.1080/00220970109600653

Brame, C., & Biel, R. (2015). Test-enhanced learning: The potential for testing to promote greater learning in undergraduate sciences courses. CBE—Life Sciences Education, 14(2), es4. doi:10.1187/cbe.14-11-0208

Brothen, T., & Wambach, C. (2001). Effective student use of computerized quizzes. Teaching of Psychology, 28(4), 292–294. doi:10.1207/s15328023top2804_10

Brown, V. (2018). Evaluating technology to prevent academic integrity violations in online environments. Online Journal of Distance Learning Administration, 21(1). https://www.westga.edu/~distance/ojdla/spring211/brown211.html

Chirila, C. (2017). Auto-generative learning objects in online assessment of data structures disciplines. BRAIN: Broad Research in Artificial Intelligence & Neuroscience, 8(1), 24–34. Retrieved from www.edusoft.ro/brain/index.php/brain/article/view/672

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Cohen, D., & Sasson, I. (2016). Online quizzes in a virtual learning environment as a tool for informative assessment. Journal of Technology and Science Education, 6(3), 188–208. doi:10.3926/jotse.217

Daffin, L. W., & Jones, A. A. (2018). Comparing student performance on proctored and non-proctored exams in online psychology courses. Online Learning Journal, 22(1), 131–145. doi:10.24059/olj.v22i1.1079

Davies, G. (2015). Online MCQ assessment anxiety amongst first year undergraduate psychology students: A case study. Journal of Perspectives in Applied Academic Practice, 3(1), 84. doi:10.14297/jpaap.v3i1.143

Denton, D. (2014). Using screen capture feedback to improve academic performance. TechTrends, 58(6), 51–56. doi:10.1007/s11528-014-0803-0

Dunlosky, J., Rawson, K., Marsh, E., Nathan, M., & Willingham, D. (2013). Improving students' learning with effective techniques: Promising directions for cognitive and educational psychology. Psychological Science in the Public Interest, 14(1), 4–58. doi:10.1177/1529100612453266

Endres, T., & Renkl, A. (2015). Mechanisms behind the testing effect: An empirical investigation of retrieval practice in meaningful learning. Frontiers in Psychology, 6(1054), 1–6. doi:10.3389/fpsyg. 2015.01054

Espasa, A., & Meneses, J. (2010). Analysing feedback processes in an online teaching and learning environment: An exploratory study. Higher Education, 59(3), 277–292. doi:10.1007/s10734-009-9247-4

Evans, B., & Culp, R. (2015). Online quiz time limits and learning outcomes in economics. E-Journal of Business Education & Scholarship of Teaching, 9(1), 87–96. Retrieved from https://files.eric.ed.gov/fulltext/EJ1167369.pdf

Gibson, S. I. (2015). Promoting an active form of learning out-of-class via answering online "study questions" leads to higher than expected exam scores in General Biology. Peerj, 3, e1322. doi:10.7287/peerj.preprints.1223v1

Griswold, L. A., Overson, C. E., & Benassi, V. A. (2017). Embedding questions during online lecture capture to promote learning and transfer of knowledge. American Journal of Occupational Therapy, 71(3), 7103230010p1–7103230010p7. doi:10.5014/ajot.2017.023374

Gurung, A. R. (2003). Pedagogical aids and student performance. Teaching of Psychology, 30(2), 92–95. doi:10.1207/s15328023top3002_01

Gurung, A. R. (2015). Three investigations of the utility of textbook technology supplements. Psychology Learning & Teaching, 14(1), 26–35. doi:10.1177/1475725714565288

Hammond, H. G., Coplan, M. J., & Mandernach, B. J. (2018). Administrative considerations impacting the quality of online teaching. Online Journal of Distance Learning Administration, 21(4). Retrieved from https://www.westga.edu/~distance/ojdla/winter214/hammond_coplan_mandernach214.html

Johnson, J. A., & McKenzie, R. (2013). The effect on student performance of web-based learning and homework in microeconomics. Journal of Economics and Economic Education Research, 14(2), 115–125. Retrieved from https://www.abacademies.org/articles/jeeervol14no22013.pdf

Jorczak, R. L., & Dupuis, D. N. (2014). Differences in classroom versus online exam performance due to asynchronous discussion. Journal of Asynchronous Learning Networks, 18(2), 67–75. doi:10.24059/olj.v18i2.408

Karpicke, J., & Blunt, J. (2011). Retrieval practice produces more learning than elaborative studying with concept mapping. Science, 331(6018), 772–775. doi:10.1126/science.1199327

Karyotaki, M., & Drigas, A. (2016). Online and other ICT-based assessment tools for problem-solving skills. International Journal of Emerging Technologies in Learning, 11(4), 56–60. doi:10.3991/ijet.v11i04.5339

Koehler, N. A., Thompson, A. D., Correia, A., & Hagedorn, L. S. (2015). Designing online software for teaching the concept of variable that facilitates mental interaction with the material: Systemic approach. Educational Technology Research and Development, 63(1), 97–124. doi:10.1007/s11423-014-9357-2

Lee, H., & Ahn, D. (2017). Testing prepares students to learn better: The forward effect of testing in category learning. Journal of Educational Psychology, 110(2), 203–217. doi:10.1037/edu0000211

Lee-Post, A., & Hapke, H. (2017). Online learning integrity approaches: Current practices and future solutions. Online Learning, 21(1), 135–145. doi:10.24059/olj.v21i1.843

MacKenzie, L., & Ballard, K. (2015). Can using individual online interactive activities enhance exam results? Journal of Online Learning & Teaching, 11(2), 262–266.

Marden, N. Y., Ulman, G., Wilson, F. S., & Velan, G. M. (2012). Online feedback assessments in physiology: Effects on students' learning experiences and outcomes. Advances in Physiology Education, 37(2), 192–200. doi:10.1152/advan.00092.2012

Martínez-Argüelles, M., Plana, D., Hintzmann, C., Batalla-Busquets, J., & Badia, M. (2015). usefulness of feedback in e-learning from the students' perspective. Intangible Capital, 11(4). doi:10.3926/ic.622

Miguel, J. (2016). Intelligent data analysis for e-learning: Enhancing security and trustworthiness in online learning systems. [N.p.]: Academic Press.

Milner, R., Parrish, J., Wright, A., Gnarpe, J., & Keenan, L. (2015). Research and teaching: Exploring the use of an online quiz game to provide formative feedback in a large-enrollment, introductory biochemistry course. Journal of College Science Teaching, 45(2), 86–97. doi:10.2505/4/jcst15_045_02_86

Moreira, B. R. T., Pinto, R. S. S., Starling, D. S. V., & Jaeger, A. (2019). Retrieval practice in classroom settings: A review of applied research. Frontiers in Education, 4(5), 1–16. doi:10.3389/feduc.2019.00005

Neroni, J. J., Gijselaers, H. M., Kirschner, P. A., & de Groot, R. M. (2015). The Adult Learning Open University Determinants (ALOUD) study: Biological and psychological factors associated with learning performance in adult distance education. British Journal of Educational Technology, 46(5), 953–960. doi:10.1111/bjet.12288

Northcutt, C., Ho, A., & Chuang, I. (2016). Detecting and preventing "multiple-account" cheating in massive open online courses. Computers & Education, 1007, 71–80. doi:10.1016/j.compedu.2016.04.008

Nunes, M. B., & McPherson, M., (Eds). (2016). MCCSIS: Multi Conference on Computer Science and Information Systems. Proceedings of the International Conference on e-Learning (Madeira, Portugal, July 1–4, 2016). International Association for Development of The Information Society. Retrieved from http://www.iadisportal.org/digital-library/iadis-international-conference-e-learning-2016-part-of-mccsis-2016

Okada, A., Scott, P., & Mendonça, M. (2015). Effective web videoconferencing for proctoring online oral exams: A case study at scale in Brazil. Open Praxis, 7(3), 227–242. doi:10.5944/openpraxis.7.3.215

Owens, H. S. (2016). Cheating within online assessments: A comparison of cheating behaviors in proctored and unproctored environments. Dissertation Abstracts International Section A, 77.

Paulson Gjerde, K., Padgett, M. Y., & Skinner, D. (2017). The impact of process vs. outcome feedback on student performance and perceptions. Journal of Learning in Higher Education, 13(1), 73–82. Retrieved from https://files.eric.ed.gov/fulltext/EJ1139724.pdf

Plana-Erta, D., Moya, S., & Simo, P. (2016). The effectiveness of instructor personalized and formative feedback provided by instructor in an online setting: Some unresolved issues. Electronic Journal of E-Learning, 14(3), 196–203. Retrieved from http://www.ejel.org/volume14/issue3/p196

Roediger, H. L., Agarwal, P., McDaniel, M., & McDermott, K. (2011). Test-enhanced learning in the classroom: Long-term improvements from quizzing. Journal of Experimental Psychology, 17(4), 382–395. doi:10.1037/a0026252

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. Trends in Cognitive Sciences, 15(1), 20–27. doi:10.1016/j.tics.2010.09.003

Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. Psychological Science, 17(3), 249–255. doi:10.1111/j.1467-9280.2006.01693.x

Sabag, N., & Kosolapov, S. (2012). Using instant feedback system and micro exams to enhance active learning. American Journal of Engineering Education, 3(2), 115–122. doi:10.19030/ajee.v3i2.7442

Shepard, L. (2000). The role of assessment in a learning culture. Educational Researcher, 29(7), 4–14. doi:10.3102/0013189X029007004

Snooks, M. (2004). Using practice tests on a regular basis to improve student learning. New Directions for Teaching and Learning, 2004(100), 109–113. doi:10.1002/tl.178

Stack, S. (2015). Learning outcomes in an online vs traditional course. International Journal for the Scholarship of Teaching & Learning, 9(1), 1–18. doi:10.20429/ijsotl.2015.090105

Steadman, R. G. (2015). Establishing an atmosphere for critical thinking in the online classroom. Journal of Instructional Research, 43–11. doi:10.9743/jir.2015.1

Stowell, J. R., & Bennett, D. (2010). Effects of online testing on student exam performance and test anxiety. Journal of Educational Computing Research, 42(2) 161–171. doi:10.2190/EC.42.2.b

Sullivan, D. P. (2016). An integrated approach to preempt cheating on asynchronous, objective, online assessments in graduate business classes. Online Learning, 20(3), 195–209. doi:10.24059/olj.v20i3.650

Waheed, M., Kaur, K., & Qazi, A. (2016). Students' perspective on knowledge quality in eLearning context: A qualitative assessment. Internet Research, 26(1), 120–145. doi:10.1108/intr-08-2014-0199

Wielicki, T. (2016). Statistical measures of integrity in online testing: Empirical study. In: Proceedings of the 10th International Conference e-Learning (pp. 169–173). Organized by IADIS International Association for Development of the Information Society. Retrieved from http://www.iadisportal.org/digital-library/statistical-measures-of-integrity-in-online-testing-empirical-study

Wojcikowski, K., & Kirk, L. (2013). Immediate detailed feedback to test-enhanced learning: An effective online educational tool. Medical Teacher, 35(11), 915–919. doi:10.3109/0142159X.2013.826793

Xu, X., Kauer, S., & Tupy, S. (2016). Multiple-choice questions: Tips for optimizing assessment in-seat and online. Scholarship of Teaching and Learning in Psychology, 2(2), 147–158. doi:10.1037/stl0000062

Yang, Y., Taylor, J., & Cao, L. (2016). The 3 × 2 achievement goal model in predicting online student test anxiety and help-seeking. International Journal of E-Learning & Distance Education, 31(1), 1–16. Retrieved from www.ijede.ca/index.php/jde/article/view/914

Yilmaz, R. (2017). Problems experienced in evaluating success and performance in distance education: A case study. Turkish Online Journal of Distance Education (TOJDE), 18(1), 39–51. doi:10.17718/tojde.285713