

Improving Learning Outcomes: Unlimited vs. Limited Attempts and Time for Supplemental Interactive Online Learning Activities

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Abstract

Research indicates the use of interactive online learning (IOL) instructional strategies such as multiple choice, "drag and drop" matching exercises, and case discussions, in online courses enhances learning and results in better learning outcomes. While some instructors might use interactive resources for regular assessments that only allow for one attempt, this experiment examines whether limiting the attempts and the time to complete IOL instructional strategies significantly improves learning outcomes as measured by performance scores on two required exams. The author posit that students who have limited attempts (2) and limited time (20 minutes) will in fact read the chapters before attempting to complete the interactive online activities, thus increasing the correlation between the interactive online activity scores and exam scores. Unlimited attempts and unlimited time provide students with the opportunity to search the textbook for the answers without reading the assigned chapters.

As anticipated, the experimental groups with limited attempts and limited time on the IOL activities did demonstrate a statistically significant relationship to combined exam scores. The findings indicate that limited attempts and limited time on formative assessments correlated with exam scores while those formative assessments without constraints did not.

Keywords: interactive online learning (IOL) strategies, asynchronous, community of inquiry learning effectiveness, distance education, online education

1. Introduction

Many textbook publishers now provide interactive online learning (IOL) activities for students on their websites. In a typical online course, professors assign chapter readings and students are then expected to complete interactive learning activities such as online quizzes, matching exercises, interactive exercises requiring calculations, video and case discussions, and video tutorials based on their understanding of the textbook material. This experiment examines whether limiting student access to individual online learning activities to just two attempts and to twenty minutes versus unlimited attempts and unlimited time can induce students to read the assigned chapters before attempting to complete the interactive online activities, thus resulting in improved learning outcomes as measured by higher exam scores when correlated with IOL scores.

1.1 Growth of Online Learning

According to Seaman, Allen & Seaman (2018), in their annual Online Learning Consortium study, distance education enrollments have increased for the fourteenth straight year; but while both distance and overall enrollments grew during the 10-year period from 2002 to 2012, overall enrollments declined for four straight years while distance enrollments steadily increased. Aslanian and Clinefelter (2014) reported that more than 80% of public universities and half of private colleges offer at least one fully online program, 5.5 million students (26 percent of all college students) took at least one online course and 13 percent (2.6 million students) studied fully online; while the percentage of students studying online continues to grow, the rate of the growth is slowing (possibly due to the growing size of the online population). As competition intensifies, students are less concerned with convenience while placement rates, prices, reputation of the institution, and credit transfer are gaining in importance (Aslanian & Clinefelter, 2014).

Growth of distance learning has continued despite lack of support by some faculty; the proportion of chief academic leaders who say online learning is critical to their long-term strategy rose to 66 percent in 2013 but dropped to 63.3 percent in 2014 (Allen & Seaman, 2018). That number was less than 50 percent in 2002 (Allen & Seaman, 2018). One factor in the acceptance of online learning is the suggestion that there was no significant difference in learning outcomes between face-to-face and online instruction (Larson & Sung, 2009). In a 2010 U. S. Dept. of Education report, a meta-analysis and review of 50 studies conducted between 1994 and 2006 comparing online to face-to-face, found online students performed modestly better than those receiving the traditional face-to-face instruction ("Evaluation of evidenced-based", 2010). In research conducted by Wagner, Garippo, & Lovaas (2011), results of a longitudinal comparison of online versus traditional instructional delivery methods, indicate there is no significant difference in student performance between the two methods of delivery. However, Tanyel & Griffin (2014), in a ten-year study that compared outcomes for online versus face-to-face instructions, reported a "12 percent difference in the percent of students receiving credit for a face-to-face section of the same course and a 0.15 higher overall GPA".

1.2 Learning Theories

Even if the term "lifelong learner" is not an apt description of most people, many find themselves in the position of needing to learn new skills outside of a traditional classroom. However, most people have never been taught how to study effectively and efficiently. Thus, all learners, whether pursuing a new hobby or a new job, could benefit from principles and practices that lead to better learning comprehension, retention, and transfer.

1.2.1 Effective Learning Techniques Summary

According to Bjork, Dunlosky, & Kornell (2013), learners need to be active participants in the learning process, not simply recording or memorizing material for short-term gain. Based on a summary of recent research on the effective learning techniques, Bjork et al. (2013) report the following:

- Spacing study sessions and interleaving (successive study sessions on separate to-be-learned tasks) increase learner effectiveness.
- Students retain information better if they first study their notes and then try to reproduce them without looking at the original notes.
- Spending enough time studying is important but email, online shopping, social networks, YouTube, etc. should not be included in the time tally.
- Cramming can work short-term and provide good recall in a short retention period; however, this can in turn erroneously impact a learner's judgment of their own degree of learning.
- Key to effective learning is the storage and retrieval of information stored in long-term memory; similar to the mindset that embraces the notion that learning abilities are not fixed, information storage capacity is not limited but continues to expand through the meaningful coding, linking, and storage of new information.

1.2.2 Model of School Learning

Some theories stand the test of time, in spite of technological changes. In the 1960's Carroll developed a model in which the factor of time played a central role. According to Carroll (1963), the degree of learning attained on a given task is a function of the time spent on the task divided by the time needed for task mastery, and "the learner will succeed in learning a given task to the extent that he spends the amount of time that he needs to learn the task." The framework was made up of five variables that contribute to the effectiveness of instruction:

- **Aptitude:** The amount of time a student needs to learn a given task to an acceptable "criterion of mastery under optimal conditions of instruction and student motivation" (1989).
- **Opportunity:** Amount of time available for learning both in class and within homework.
- **Ability to understand instruction:** relates to learning skills, information needed to understand, and language comprehension.
- **Quality of instruction:** The effectiveness with which the unit of instruction is delivered. If quality of instruction is bad, time needed will increase.
- **Perseverance:** Amount of time a student is willing to spend on a given task actively participating in the learning process. It essentially measures motivation for learning. (Carroll, 1989).

Carroll (1963) hypothesized the shorter the time needed for learning, the higher the aptitude, with student aptitude related to time required to learn; he believed that all children would learn well but there could be a difference in time

to achieve mastery.

Derived from Carroll's work, the U.S. Department of Education stated the following;

How much time students are actively engaged in learning contributes strongly to their achievement? The amount of time available for learning is determined by the instructional and management skills of the teacher and the priorities set by the school administrator. ("What works", 1986).

In another section, it emphasized "accomplishment in a particular activity is often more dependent upon hard work and self-discipline than on innate ability" ("What works", 1986).

1.2.3 Exploring Cramming

Many students employ the technique of cramming, especially if teaching assessment is only done at that end of a course; research suggests while cramming can be effective for the short term, it is ineffective for long term learning retention. To measure the effectiveness of cramming, two surveys was administered to one hundred sixty students in nine sections of an upper division marketing course who had taken a Principles of Marketing course between two and eleven quarters prior to taking the upper division marketing division course. One survey addressed different study strategies; the other (a master test) measured comprehension and retention of material from the previously taken Principles of Marketing course (McIntyre & Munson, 2008). Results indicated that 1) high cramming students, even though they may have earned good grades on an exam, forget most what is learned, 2) cramming lead to little difference in the Principles of Marketing course and was associated with a lower overall GPA, 3) there was significant negative impact on the master test from cramming and the more weeks that passed, the lower master test score if the cramming score was high, and 4) students who take a structured approach to studying retain more material (McIntyre & Munson, 2008).

1.2.4 Learning vs. Performance

Performance is what is observed and measured; while learning is the change in knowledge or understanding that has taken place at the point of instruction, performance can be a highly unreliable measure of whether learning has indeed taken place (Bjork & Bjork, 2011). The authors posit that the encoding and retrieval processes that support better conditions of learning include varying the environmental settings such as using two different rooms, interleaving by mixing up closely-related topics, spacing study sessions (not mass sessions), and frequent testing as an alternative to reading material over and over (Bjork & Bjork, 2011).

1.2.5 Self-regulated Learning Techniques

In a monograph, ten easy-to-use, simple learning techniques were thoroughly reviewed and recommendations made on the relative utility of each (Dunlosky, Rawson, Marsh, Nathan, and Willingham, 2013). Two techniques (practice testing and distributed learning) received high utility assessments because they had been shown to boost the performance of student regardless of age and ability (Dunlosky et al., 2013). Practice testing in this context does not include summative assessments used by an instructor but does include activities that students complete on their own such flashcards, or tests included in electronic supplements offered by a publisher (Dunlosky et al., 2013). Distributed practice (or spacing) is represented by spreading study activates over a period of time; it is believed to contribute to long-term retention and it works for students of all ages and with a variety of materials (Dunlosky et al., 2013). Interleaving, mentioned by other researchers as an effective learning technique, was one of three techniques (elaborative interrogation and self-explanation made up the other two) who received moderate utility due to limited evidence for efficacy; it is interesting to note that highlighting and rereading, both popular techniques used by many students, were deemed low utility because they did not consistently improve student performance (Dunlosky et al., 2013).

1.2.6 Deep vs. Superficial Learning

A four-year longitudinal study collected original learning data of individual students from 8 to 101 weeks following the completion of a Consumer Behavior course; a total of 374 students completed a multiple-choice final exam (Bacon & Stewart, 2006). Retention data was collected in a marketing capstone course which included a subset of 50 questions from the Consumer Behavior final exam; the authors posit that deep learning is related to retention, and that knowledge acquired at a deep level of understanding is more likely to be retained (Bacon & Stewart, 2006). When students strive to comprehend material and go beyond memorization, they are more likely to score well on tests that measure comprehension (Bacon & Stewart, 2006). The research also supported a relationship between retention and repeated testing and spaced study sessions (Bacon & Stewart, 2006). The authors suggest that deep level learning is more likely to take place if professors sacrifice breadth for depth of topics discussed in class,

"chunk" the course material, use cumulative exams so students can relearn and reintegrate material, and provide frameworks such as the four P's in Marketing Principles courses (Bacon & Stewart, 2006).

1.3 Universal Design for Learning

Dean, Lee-Post & Hapke (2017) incorporated four instructional tools (Power Point, lecture notes, clickers, and Mind Tap, a digital learning tool provided by a textbook publisher) in an introductory marketing class of over 600 students at a large American university. Utilizing the framework established by neuroscience and education that identified three basic brain activities involved in learning (recognition activities - the what of learning; strategic activities - the how of learning; affective activities - the why of learning), the authors implemented a UDL environment for a marketing management class in the fall and spring semesters, using the same instructor, materials, and instructional tools (Dean et al., 2017). Two methods were used to collect data; one, to measure perceived learning, was administered in-class before the final exam, and the other one used online analytics to measure actual learning and use of instructional tools (Dean et al., 2017). The survey results indicated that while students perceived that each of the instructional tools helped them learn, they believed the lecture notes and Power Point slides were most effective, followed by clickers and MindTap (Dean et al., 2017). The objective data analysis suggested that the actual use of MintTap had a positive and significant impact on actual learning, but clickers did not (Dean et al., 2017)

1.4 Application of Learning Theories to This Experiment

Themes discussed in the aforementioned learning theories section in this experiment report that have some bearing on this experiment include interleaving, spacing of study sessions, use of electronic sources, and frequent testing. Interleaving is evident in the variety of interactive learning modalities used in the experiment, including online quizzes, matching exercises, video and case discussions. Since the material for the weekly interactive activities were derived from the same publisher's test bank that populated the midterm and final exam, study sessions were spaced for each module and represented practice testing for the summative evaluations. In addition, the SmartBook version of the textbook which came with the rental agreement, students could first read the chapter through self-study and then test themselves; a "pop up" avatar would guide them through the process. Not explored in depth here but mentioned in several of the articles were some of the positive benefits of using multiple choice questions (which make up some the IOL's used in this experiment); some authors suggest a correlation with short answer tests while authors posit they may be instrumental in long term learning if students can learn from being provided the correct answer at a later date.

1.5 Strategies Used in Online Learning

Strategies to promote online interactions can include a wide array of activities to help students apply or demonstrate what they are learning. These activities can be done in or out of a class, as individuals or in groups, with or without technology. According to Crawford (2001), integration of productive interactive activities can develop higher-level thinking skills and can motivate students to complete the online course. Textbook publishers are investing in the enhancement of online education by providing interactive, online activities to accompany their texts. Many have online versions of textbooks, e-books, and website access bundling options for students. These websites typically provide video tutorials, multiple-choice, "drag and drop," and interactive exercises for students, video and traditional case discussions, and instructor resources. The role these interactive, online resources play in improving learning outcomes is beginning to be studied.

Recently, a textbook publisher hosting a site of online resources provided the results from 20 different case studies completed by instructors who used the online resources in their courses ("The impact of Connect," 2016). The aggregated case study data indicated a 20-point improvement in student retention, from 70.1% to 89.9%, a 13-point improvement in pass rates, from 72.5% to 85.2%, and an average grade increase of more than five points ("The impact of Connect," 2016).

Interactive online exercises for the practice of core concepts by individual students may serve the same function as a tutor, working one-on-one with a student, which is a learning aid that is not practical to offer to every study due to high enrollments in traditional college courses. In addition to individual practice, well-designed online courses can support the development of a Community of Inquiry (CoI) which provides multiple types of interactions for students (Swan, Shea, Fredericksen, Pickett, Pelz & Maher, 2000). In a CoI:

- Students interact with the content and ideas presented in the course materials such as the text (Student-Content interaction),
- Students interact with instructors through formative feedback on assignments and in discussion forums (Student-Instructor interaction), and

- Students interact with their peers (Student-Student interaction) through debate, discussion, and collaboration on assignments and projects (Swan, 2003).

In an effort to gain a better understanding of the current state of CoI research, 73 articles from Google Scholar were identified and examined (Befus, Cleveland-Innes, Garrison, Koole & Vaughan 2014). The researchers concluded that the "CoI model is likely to continue to be popular although technologies, research forms and educational practices are also likely to change" (Remesal & Friesen, 2014).

A recent research study investigated whether the inclusion of individual online interactive activities from a publisher's website was related to improved student learning outcomes; Pearson's Product Moment Correlation Analysis was conducted to measure the relationship between the total combined scores on two exams and the total individual online interactive semester scores of 133 students at a large Midwestern university who were enrolled in five sections of a Principles of Marketing undergraduate course (MacKenzie & Ballard, 2015).

Pearson's product moment correlation analysis was used to measure the relationship between exam scores and IOL activities overall and then by section, and the results demonstrated that overall there was a positive and significant correlation between total exam scores and IOL activities scores for all sections combined ($r=.585$) (MacKenzie & Ballard, 2015). Thus, the more students engaged with the supplemental publisher online activities, the better their overall exam performance was for the semester. When analyzing this relationship in individual sections, similar significant results were noted. In each of the five sections, a significant and positive correlation emerged between total exam scores and scores for the IOL activities (MacKenzie & Ballard, 2015). The findings that emerged from this study support the research cited by one textbook publisher that suggests that online interactive tools used as an adjunct to a course can enhance student performance ("Evaluating the all," 2014). Not only are the correlations consistently significant overall and by section, but also a review of the means and standard deviation, suggests that these types of online supplements hold promise for students who are not performing well in the course.

1.6 Technology on the Move

The use of technology is having impact on all facets of human life and is experiencing an exponential growth rate that is unlikely to slow down in the near term. Undoubtedly, cutting edge technologies are already making their way into the workplace; if educators are to properly prepare their students for gainful employment, they must themselves function as important role models by, at a minimum, exposing their students to such new technologies as 3D printing, artificial intelligence, virtual reality, and augmented reality (Crittenden, Biel & Lovely, 2018). If used as a tool for specific objectives and outcomes, actual integration of new technologies into the classroom can foster critical thinking skills that lead to greater learning outcomes as succinctly put forth:

Integrating intellectual challenges, that are learner-centered, within the learning environment, provide for deeper retention while affording opportunities for reflection, communication, and a broader conceptual perspective toward the body of knowledge. (Crittenden et al., 2018)

Professors who lack the firsthand experience in any of the new technologies can supplement what happens in the classroom with outside speakers, attendance at conferences, and participation in training workshops

1.7 Formative Assessments

Formative assessments monitor student by providing ongoing feedback while summative assessments evaluate student learning at the end of an instructional unit. (<https://www.cmu.edu/teaching/assessment/basics/formative-summative.html>)

For nearly ten years, a large group of first year, undergraduate, biology students were provided with both offline (paper-based) and online assessment resources; both qualitative and quantitative research methods were used to gauge whether the offline and online assessment resources were used by students, and if used, whether they contribute to final performance (Peat & Franklin, 2002). Most of the students who had attempted or completed the various assessment resources found them to be at least useful, if not extremely useful; students responded less positively to summative responses (weekly quiz, report and poster presentation) than to formative resources (mid-course exam, self-assessment modules and weekly self-text quiz) (Peat and Franklin, 2002).

The IOL activities which form the basis for this research experiment would be considered formative assessments.

2. Participants in the Experiment

The experiment included scores from 57 students from a small U.S.A. university accredited by the Commission on

Higher Education of the Middle States Association of Colleges and Schools, enrolled in two separate online sections of an introduction to a Principles of Marketing course, one section in fall semester, 2018 and the other in spring semester, 2018. In addition to case discussions and a team marketing plan, the students were required to complete the weekly individual online interactive learning (IOL) activities over a total of 14 weeks \ and to take two exams; the midterm occurred after the seventh week, the non-cumulative exam was offered at the end of semester, week 18. Both exams used 50 multiple choice, two points apiece; exams were randomized from a database of over 450 questions; thus, no two exams were alike. Thirty-two students in the Spring 2018 section had the opportunity to take the IOL activities as many times as they desired and for any length of time; twenty-five students were allowed twenty minutes to complete the IOL activities and two attempts. The theory behind the experiment was that with limited attempts and limited time, students would more likely read the book rather than simply looking up answers to the IOL, resulting in better exam scores. Students did not collaborate with one another in performing the publisher's website activities. All activities presented and completed on the publisher's website were individual; they ranged from seven to fifteen activities for a total of ten points per week. The total possible IOL score for the semester was 180 points.

The two exams required for the course, a midterm and a final, covered core marketing topics and were worth 100 points each for a total possible exam score for each student of 200 points. The midterm exam covered content presented in the first half of the semester and the final exam covered content presented in the second half of the semester.

3. Method of Analysis

The purpose of this experiment was to determine whether constraining student attempts by time (20 minutes) and attempts (2) on formative assessments (IOL activities from the publisher's website) is related to improved performance on summative assessment (exams). In order to investigate this, Spearman's Rank Correlation Coefficient was performed to measure the relationship between the total combined scores on the two exams and the total individual online interactive semester scores for both conditions sampled: unconstrained attempts and constrained attempts.

4. Data Analysis and Results

The experimental groups with unconstrained attempts ($n = 32$) and the experimental groups with constrained attempts ($n = 25$) were analyzed separately with the R statistical software package (R Core Team, 2018). Prior to performing the analysis, data cleansing operations were performed and the data were reviewed for fitness. As an initial step, student records were excluded from the data set in cases that precluded analysis. The experimental groups with unconstrained attempts included seven students who dropped the class and therefore completed neither the IOL activities nor the exams. The experimental groups with constrained attempts included one student who stopped the IOL activities after the two-week trial period, one student auditing the class and two students who dropped the class. A visual inspection of the histograms for the variables under review suggested that the variables should not be assumed to be normally distributed. The Shapiro-Wilk test was performed to test the assumption that the data were normally distributed (Ghasemi & Zahediasl, 2012). The Shapiro-Wilk test results, summarized in Table 1, confirmed that the data were not normally distributed: the tests rejected the null hypothesis (the data are normally distributed) for the combined exam scores and the combined IOL scores for both experimental groups. In other words, the assumption could not be made that the variables in question met the requirements for parametric correlation tests such as the Pearson Product Moment Correlation Coefficient. Therefore, Spearman's Rank Correlation Coefficient was used to measure the relationship between the combined exam scores and the combined IOL scores.

Table 1. Shapiro-Wilk Test of Normality

Experimental groups	Total IOL (<i>P</i> -value)	Total Exams (<i>P</i> -value)
Unconstrained Attempts	3.19e-05	1.239e-06
Constrained Attempts	0.0002133	0.0003322

Table 2 summarizes the results of Spearman's Rank Correlation Coefficient for both experimental groups. As theorized, the constrained experimental groups with limited attempts and limited time for the IOL activities demonstrated a statistically significant positive relationship to the combined exam scores. In fact, the proportion of shared variance between the IOL activities and the combined exam for the constrained experimental groups was over 30% (Coefficient of determination: 0.3315173). On the other hand, the unconstrained experimental groups provided no

evidence of a statistically significant relationship between the IOL activities and the exam scores. In short, judging purely from the results of this experiment, the conclusion is made that constraining students with limited attempts and limited time to complete IOL activities offers improvements in the quality of feedback on these formative assessments. With that being said, these results are offered with caution due to a number of limiting factors to be discussed below.

Table 2. Spearman's Rank Correlation Coefficient

Experimental groups	rho	P-value
Constrained Attempts	0.5757753	0.002597
Unconstrained Attempts	0.1533802	0.402

5. Limitations

While the author are encouraged by the results of this experiment, the results are bound by important limitations due to sample size, data fitness, technique limitations and narrowness of scope. The sample sizes limited the ability to apply the results beyond this specific sample. In other words, the results are not representative for all students based on this limited sample size. Since the experiment relies on correlation, no claims can be made regarding causation because the technique cannot control for the many variables involved in online learning. Moreover, the use of a non-parametric technique like Spearman's Rank Correlation Coefficient means that the analysis sacrifices any knowledge regarding the magnitude of the correlation. With rank correlations only the direction of the relationship is known, but no inference can be made about the magnitude of the changes involved in the relationship. Furthermore, the correlation coefficients were tested with the *concur* package in R (Diedenhofen and Musch, 2015) to confirm that the difference in correlations between the two experimental groups was significantly different. The test of significance for the difference between two correlations based on independent groups demonstrated that random variation is a possible if not likely explanation for difference between these measurements. While the author posit a practical significance to the experiment based on the observations, the study falls short of a statistically significant difference between the experimental groups. Finally, the scope of the experiment is extremely narrow including the analysis of two sections of one course design and one set of IOLs on a singular publisher's website. The differences in course design cannot be accounted for in the results. As with other scientific studies, replication offers the best path to discovering the truth. Colleagues are encouraged to replicate the experiments for themselves to verify the results of the study.

6. Conclusion

The findings that emerged from this experiment suggest that limiting the number of attempts for IOL activities (formative assessments) and limited time may correlate with better student performance on exams (summative assessments). Since formative assessments should in some way prepare students for the more formal and consequential summative assessments, instructors would want to tune the delivery of formative assessments so that they provide as much feedback to students and teachers regarding their progress as possible. The experiment results suggest that offering students unlimited attempts at formative assessments may provide less of a signal of progress to students seeking to improve their learning.

It might be construed from the experiment results that spending more time with chapter content through limited attempts (under less pressure to get "it right the first time") and limited time translates into more frequent and deeper engagement with the material and consequently, better outcomes on midterm and final tests.

Understanding student reading habit is another challenge to interpreting IOL results. Studies have found that many college students are non-compliant when it comes to reading course material (Starcher and Proffitt, 2011). As such, many of the students completing IOL activities may be doing so as a substitute to reading the material. Capturing this information may help researchers to better understand the effectiveness of IOL. Students' lack of preparedness also may account for poor formative (IOL) and summative (final grade) results.

7. Future Research

A future experiment could examine student performance comparisons between those sections of the course, both online and face-to-face, that include IOL activities and those that do not. In addition, college students could be surveyed to gather anecdotal information on their perceptions of learning outcomes as a result of performing IOL

activities.

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