THE EFFECTS OF ONLINE MATERIALS ON STUDENT PERFORMANCE: TYPES OF RESOURCES, MODE OF DELIVERY, AND SESSION LENGTH

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ABSTRACT

Owing to an exponential increase in the number of courses offered online, it is crucial to understand this mode of delivery on a deeper level. In this study, associations among course performance, the use of online resources (i.e., online homework assistance, practice questions and practice tests), mode of delivery (online versus in-person), and session length (Fall/Winter for 8 months versus Spring/Summer for10 weeks) were examined. Archival data were used from an educational website for an introductory statistics course at a medium-sized Canadian university. Anonymized data were retrieved from 738 students enrolled in the course between 2018 and 2021. Course performance was measured by final course grades and use of resources was assessed in terms of the number of site visits and downloads. It was found that use of online resources was significantly and positively correlated with course performance. However, session length and mode of delivery did not yield significant differences in terms of final course grades. Future studies could examine potential moderators in the relationships between the use of resources with the session length, the delivery method, and course performance to see the effectiveness of the resources in various course delivery models (in-person, hybrid, synchronous online, asynchronous online, etc.).

Keywords: *online courses, course performance, study resources, in-person courses, mode of delivery.*

INTRODUCTION

The modernization of education has brought a proliferation of online course content. This ubiquity of online course delivery and online course content has been spurred by the COVID-19 pandemic. It is now common for instructors to upload lecture notes, quizzes, practice tests, and other such supplementary materials for the students' perusal. Moreover, since the onset of the COVID-19 pandemic, it is becoming increasingly common to have blended courses (i.e., partially online) and fully online courses. What is less common is the evaluation of such techniques on overall student success, especially in actual courses. Most of the research done has been on simulated courses, or courses designed specifically for the purpose of conducting research (Atici & Polat, 2010).

LITERATURE REVIEW

Theories Regarding Online Learning

Research suggests that use of online resources can assist students to move past passive acquisition of knowledge and encourage reflection, critical thinking, and active learning (Dowell & Small, 2011). According to the user control theory, when the student has more autonomy in their learning activities as opposed to a rigid and

predetermined structure, the student learns more effectively (Eveland & Dunwoody, 2001). Web-based resources allow more freedom in terms of the order and duration of content read, and thus learning should be more effective with the use of online resources (Eveland & Dunwoody, 2001). Accordingly, if the student can actively construct their learning experience and determine the intervals and topics more independently within a predefined structure, it could possibly facilitate a more effective learning environment. The cognitive flexibility theory corroborates this claim as it states that using web-based tools allows for a better understanding of complex concepts due to the ability to process auditory and visual information simultaneously (Arbaugh, 2005). Self-determination theory states that learners have autonomy, competence, and related needs that require consideration in pedagogy (Deci & Ryan,1985). Moreover, according to this theory, individuals with high self-determination have higher intrinsic motivation (Deci & Ryan,1985). Online support is one medium by which learners' needs can be supported. In line with this reasoning, students who have access to online tools that satisfy their desires for autonomy and their feelings of competence, and that foster their motivation, are more likely to engage more actively in learning (Chiu, 2022). Being cognitively active in the learning process, specifically in multimedia, also benefits the learner in terms of information retrieval, transfer, and retention (Skuballa et al., 2018). Thus, online courses or online course materials could result in increased engagement and greater comprehension of the learning material.

However, while autonomy in determining one's own learning experience could be helpful there is also evidence to suggest that online education and resources may be less effective than in person (Eveland & Dunwoody 2001). For instance, it has been reported that hypermedia increases cognitive load and leads to less effective learning (Eveland & Dunwoody 2001; Mayer, 2019). Converting classroom environments from traditional to an online format is a challenging task owing to the lack of social presence and verbal and nonverbal cues. This could potentially hinder communication and thus hinder the effectiveness of instruction (Callister & Love, 2016).

Research examining online learning is a rapidly developing field, yet there are still multiple areas that require improvement and others yet to be thoroughly explored. Research into the pedagogy of online education could make a significant impact upon the development of this rapidly expanding new area of education. Researchers have theorized that for learning that is largely declarative, such as in mathematics, online learning could be just as, if not more, effective than in person (Callister & Love, 2016). However, for learning that is application based, wherein cues such as facial expressions and body language could assist with learning, in-person instruction appears to be the more suitable alternative (Callister & Love, 2016).

While outside the scope of the current study, there is also a relatively extensive body of research on the association between student motivation and student learning. One such theory is the self-determination theory (SDT; Chiu, 2022). The SDT states that individuals with high self-determination have higher intrinsic motivation (Chiu, 2022). Thus, students who are in classrooms and learning environments that satisfy their desires for autonomy, their feelings of competence, and foster their motivation, are more likely to engage more actively in learning (Chiu, 2022)

Past research on the Use of Online Resources

Comparisons of online tool use and course performance have been examined for over two decades (e.g., Atici & Polat, 2010; Rosen & Petty 1997). Atici and Polat (2010) compared the use of educational tools in online, in-person, and blended courses and their effect on test scores. They found that the students who were in blended classrooms (i.e., in-person instruction with online resources) outperformed the other two groups. This finding supports the notion that online resources are beneficial tools that can be utilized to boost student performance (Atici & Polat, 2010).

Recent studies on the use of supplemental course materials and their impact on student performance have focused on popular supplemental tools such as the Cengage MindTap. The use of this tool was shown to be positively correlated with final course grades (McGillicuddly & McGloin, 2018). Similarly, students enrolled in a psychology class who accessed the readings and lecture questions were more likely to perform well and to pass the course when compared to students who

either did not make use of these tools or used them less frequently (Heffner & Cohen, 2005). It was also observed that the total number of site visits, number of logins, and number of times the course schedule was accessed were significantly and positively correlated with the course performance and final course grades respectively (Heffner & Cohen, 2005). Others have found that logins and length of session both conjointly contributed to higher course grades (Cavanaugh et al., 2016). Even students with a higher grade-point-average in comparison to their classmates performed better when they made use of library eresources (Cavanaugh et al., 2016). Furthermore, students tended to find online study materials especially useful towards the end of the semester as opposed to the beginning (Rosen & Petty 1997).

Self-regulated study can be substantially improved using online resources provided by instructors in blended, traditional, or online courses (Dowell & Small, 2011). In an undergraduate marketing program, the content read and site visits were significantly, positively related to subject performance as measured by course grades (Dowell & Small, 2011). Interaction with online supplementary content was higher for students enrolled in fully online courses as opposed to those in traditional classrooms (Dowell & Small, 2011). Moreover, others have found that students with more frequent logins, access of online posts and forums, and usage of quizzes were seen to have a higher grade in the course (Hostager, 2014). However, not all studies examining online resource use have noted improvements in course performance. For example, the use of online study resources such as review videos did positively impact student satisfaction in courses, but not course performance (Zipay et al., 2020). Thus, not all mediums of online study are equally effective at improving course performance.

Whether or not an online tool affects course performance might relate to the type of resource and how students engage with it. For example, an in-depth study investigating the difference between types of resources (i.e., supplementary and optional versus supplementary and graded, and dynamic versus static) was also conducted on university students enrolled in an introductory accounting course (Lento, 2018). It was found that study resources were used as tools for cramming and their usage greatly increased during exam periods. Additionally, the use of supplementary course materials that were linked to course assessment was found to have a significant positive correlation with course performance (Lento, 2018). However, the course materials that were for self-study were only found to be more positively associated with better course outcomes when they were dynamic, such that the course materials for self-study provided auditory and visual information and not when they were static materials which only provided one such channel (i.e., either auditory or visual) (Lento 2018).

Online Versus In-Person Mode of Delivery

The body of research discussed thus far does point to a potential difference in the effectiveness of online versus in-person instruction. Many studies have found that in-person learning can be more effective than online courses. For example, Al-Dahir and colleagues (2014) examined the difference between classroom instruction and online instruction, and found that students in the traditional classroom setting performed better than those enrolled in the online class.

Importantly, such studies do not rule out extraneous factors. The equivalency theory of education postulates that students in an online or in-person learning environment are likely to have equal learning outcomes if equivalent learning environments are provided (Garratt-Reed et al., 2016; Simonson et al., 1999). According to this theory, online and traditional instruction should have comparable learning outcomes if courses are developed to ensure proper understanding with no compromise in materials covered and clarity of instruction (Lapsley et al., 2008). When two conditions with identical resources and delivery with the only difference being the delivery method were compared, it was found that the students enrolled in the online course significantly outperformed in quizzes as compared to those enrolled in the traditional classroom (Lapsley et al., 2008). However, this finding has not been consistent across studies. A study on Graduate Record Exam performance noted no significant difference in the scores between those who took online versus in-person preparation courses (Ferguson & Tryjankowski, 2009). Moreover, it has been reported that students enrolled in a traditional classroom set-up performed significantly better on final exams than those in online sections

taught by the same professor using identical final exams (Ferguson & Tryjankowski, 2009).

Similarly, Harrington (1999) conducted a study on students enrolled in a social work master's program. Grades of those in a traditional classroom versus those in a software-based content version of the course were compared and it was found that the students in the traditional classroom did better than the students in the online classroom (Harrington 1999). Additionally, another study examined students in a skills-based class for negotiation and compared the results of students enrolled in in-person classes with students enrolled in the distance learning classes (Callister & Love, 2016). The courses were designed such that there were no disparities in the content or material, the only difference was the delivery method (Callister & Love, 2016). Students in both conditions performed equally well in the written final examination; however, students enrolled in the traditional classroom made more successful negotiations than students enrolled online, and the researchers deduced that student-instructor interactions are a fundamental aspect of successful course outcomes (Callister & Love 2016).

The relationships between social interaction and learning online have also been examined by De Felice et. al. (2021). In learning interactions involving factual information, live social interaction in the form of scheduled online lessons where the instructors' hands and face were visible proved to be a more effective method of instruction for maximum information retention (De Felice et. al., 2021). Conversely, for observational learning, social cues were found to be more of a distraction. However, regardless of the type of information, live interactive classes were more beneficial than prerecorded lessons (De Felice et. al., 2021).

Differences in learning between online and in-person instruction has also been examined in the context of declarative and procedural information (Sitzmann et. al., 2006). Declarative information is based upon memory and facts whereas procedural information is related to the performance of a task (Callister & Love 2016). While both delivery methods have been found to be equally effective for procedural information, web-based deliveries are more effective for declarative knowledge (Callister & Love 2016).

Arbaugh (2005) compared the two modes of instruction and their effectiveness in terms of objectivist and constructivist learning. Objectivist learning occurs when the instructor guides learning that has a single objective truth (e.g., statistics and mathematics) whereas in constructivist learning the learner creates or constructs the knowledge activity (e.g., experiments and practical based learning) (Love & Callister, 2016). No significant differences in learning outcomes were found between the two conditions (Arbaugh, 2005). The differing findings of the effectiveness of the two teaching methods in comparison to one another certainly requires further investigation.

Student Preferences for Learning

If the course content is carefully curated it was found that student satisfaction for both forms of delivery is comparable (Garratt-Reed et al., 2016). Researchers constructed a course for the purpose of identifying the differences in the two methods of course delivery (Garratt-Reed et al., 2016). Opinion surveys taken after the courses showed no discernable difference in the two delivery methods; however, the course rating for this specifically designed course were higher than the university average in both conditions (Garratt-Reed et al., 2016). Therefore, this tailored course may have been superior in multiple ways. Specifically, the researchers applied the concept of equivalency theory (Simonson et al., 1999) to ensure that the online course was designed to cater to the difficulties encountered in distance learning and sought to overcome these impediments and produce a successful outcome (Garratt-Reed et al., 2016). Despite the success of the online version of this course, the retention rate of the students was higher in the in-person condition and the failure or dropout rate was still higher for students in the online condition (Garratt-Reed et al., 2016). It has also been noted that some students prefer the availability of online resources and that it increases their satisfaction with the course (Zipay et al., 2020). Of course, these results must be interpreted carefully and may not generalize to all online courses.

THE CURRENT STUDY

In this study we are interested in examining three distinct research questions. Past research reported that the use of online resources as assessed by site visits and content read had a positive

correlation with grades (Dowell & Small, 2011). Thus, for the current study and in our first hypothesis (Hypothesis 1a**)** we predict that the degree to which online resources are used will be positively correlated with course performance. Further, we predict that there will be a difference in the effectiveness of each study resource (Hypothesis 1b). These include homework helpers, practice questions, and practice tests.

Next, because past research (Ferguson & Tryjankowski, 2009; Harrington, 1999) has shown that online education has been less effective than in person (e.g., formats owing to different learning experiences, difference in delivery methods, and effectiveness of instruction), we predict in our second hypothesis that course performance for students enrolled in the in-person format will be greater than for those students enrolled in the online format (Hypothesis 2).

Finally, we aim to determine whether course duration has any association with course performance. We expect that the difference in length of the sessions will impact the effectiveness of instruction or learning, given that Fall/Winter and is an 8- month long, two semesters course, while the Spring/Summer term is a 10-week, condensed course. We expect a difference depending on the session length. We hypothesize that there will be a difference in course performance for students enrolled in the Fall/Winter semesters (8 months) and students enrolled in the Spring/Summer semesters (10 weeks) (Hypothesis 3).

METHODS

Participants and Procedures

We collected archival data from Sakai, a course management system for educational institutions. The sample consisted of undergraduate students enrolled in a second-year introductory statistics course in the Department of Psychology from 2018 to 2021 for both the Fall/Winter and Spring/Summer versions of the course at a medium-sized Canadian university. The data were completely anonymized.

The dataset includes information regarding the number of downloads of the study resources, final mark out of 100, session (i.e., Spring/Summer versus Fall/Winter), and format (i.e., online versus in person). The data collected from the educational website were archival. Throughout this paper, "usage of resources" refers to the number of times a certain resource was downloaded by the user.

The study resources we investigated include online homework helpers, online practice questions, and an online practice test. These are designed to address the various stages in learning throughout the course duration. The homework assistance is generic and can be used with any raw data. The online practice questions are intended to familiarize students with test questions and can be refreshed with random numbers to provide essentially an infinite number of questions as designed by the last instructor. The first two resources provide information regarding correctness of calculations, including intermediate steps, to assist the student. Finally, the practice test is a compilation of questions from past exams for the course to allow students to practice two fully written tests designed in the same format as the actual test.

Measures

For all hypotheses, final grades were used as an indicator of course performance. The course had always been taught in person but was abruptly forced to pivot to an online format in March 2020 due to the sudden onset of the COVID-19 pandemic and subsequent lockdowns. Thus, because student performance was likely affected in unforeseen ways using two formats within one academic year these data are not included in our data set. The first hypothesis examined the effectiveness of the resources; however, the data were highly skewed in terms of usage of online resources because a considerable number of students did not use any resources. Therefore, students who did not use the resource have not been included for the purpose of these analyses. We chose to examine this in a correlational manner with bootstrapping using amount of usage as our predictor variable.

Data Analysis Plan

For Hypotheses 1a and 1b we used linear regression analysis for each resource separately along with bootstrapping with 2,000 samples. To determine which resources contribute the most unique variance in course performance, we examined the R^2 values of each resource. Additionally, the university offered a credit during disruption option to students due to the uncertain circumstances surrounding the pandemic. This option allowed students to receive credit for the course

without having a grade assigned to not impact their academic average. This creates the possibility that students may have reduced their engagement and preparation for the course, which may have contributed to lower-than-expected test scores and a higher standard deviation that would typically exist for course grades. For this reason, participants with grades below 45 were not included in the analyses for the second and third hypotheses. We did not apply this filter for the data in terms of the use of resources as we expect that students who remain engaged in the course will do so regardless of the credit option. The use of the resources was completely voluntary; therefore, it should not be affected as such by the existence of alternate grade options. For these conditions we conducted an independent sample *t*-test. To address the issues of non-normality owing to many students not having used the course resources and the large difference in grades, bootstrapping was conducted with this analysis.

RESULTS

The first hypothesis examined the potential correlations between the use of resources and the course performance. To test our three resources, we ran a linear regression analysis for each resource with the final course mark separately. Again, bootstrapping was conducted due to issues with normality. Given that each resource was examined separately, the number of students in each condition was different as certain resources were not used by the same subset of students.

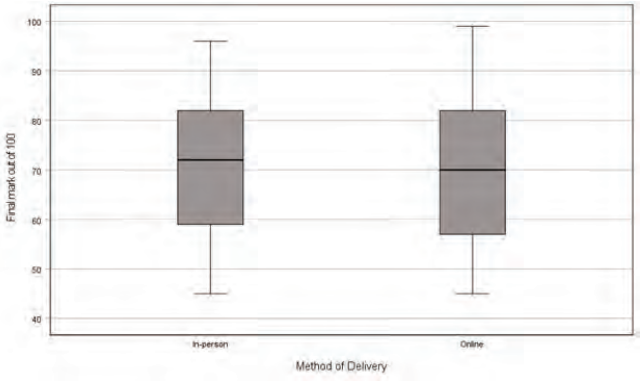
Table 1.
Regression Analysis Results for Use of Resources

						95% BCI	
Resource	M	*SD*	R	R^2	*p*	CI Lower	CI Upper
Homework Helpers	3.70	4.33	.083	.007	.09	62.01	67.30
Practice Questions	13.07	25.02	.19	.035	<.001	62.37	65.94
Practice Test	14.25	10.07	.27	.071	<.001	52.50	58.35

The overall regression analysis showed no significant correlation between final course marks and the use of homework helpers F (1, 422) = 2.95, p = .09, R^2 = .007, R^2 adjusted = .005. Additionally, the second regression analysis showed a significant positive correlation between final course marks and the use of practice questions F (1, 504) = 18.43, p < .001, R^2 = .035, R^2 adjusted = .033 and the use of a practice test F (1, 606) = 46.34, p < .001, R^2 = .071, R^2 adjusted = .070. Thus, for Hypothesis 1a, we can state that the use of online practice questions and a practice test were both significantly and positively correlated with final grade in the course.

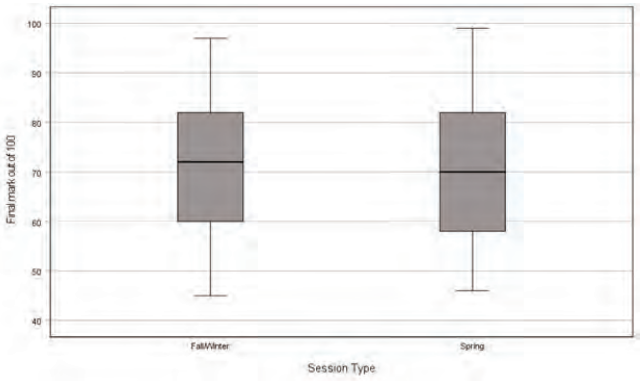
For hypotheses 2 there was no significant effect for mode of delivery t (424) = 0.87, p = .92 with the final exam grades in the in-person delivery (M = 71.31, *SD* = 13.88) not being significantly higher than the final exam grades in the online delivery method (M = 70.02, *SD* = 14.01) (see Figure 1).

Figure 1.
Box Plot for Method of Delivery



For Hypothesis 3, there was no significant effect for session type t (598) = 0.56, p = .09 with the final exam grades in the Fall/Winter session (M = 71.33, *SD* = 13.33) not being significantly higher than the final exam grades in the Spring/Summer session (M = 70.64, *SD* = 14.40) (see Figure 2).

Figure 2.
Box Plot for Session Type



DISCUSSION

The hypothesis that the use of online resources would have a positive association with the final course outcome was supported for two of three resources we examined, namely, online practice questions and an online practice test. Use of the homework helper tools were not significantly correlated with course performance; however, they were also utilized infrequently by most students enrolled in the course. Perhaps if the homework helpers had been promoted more effectively and used more often this association would also have been significant. However, because homework helpers were specifically designed to help with homework (assignment) calculations, it is possible that they do not have the same impact on test performance as practice questions and practice tests that were designed to provide explicit practice with the type of questions that appeared on the actual tests and exams.

These results are consistent with previous research findings that online resources can be utilized as important tools to enhance the learning experience for students (Arbaugh, 2005; Atici & Polat, 2010; Callister & Love, 2016; Cavanaugh et al., 2016; Chiu, 2022; Dowell & Small, 2011; Eveland & Dunwoody, 2001; Heffner & Cohen, 2005; Hostager, 2014; Lento, 2018; McGillicuddly & McGloin, 2018; Rosen & Petty 1997; Skuballa et al., 2018). We also found that use of a practice test had the highest correlation of the two significant resources and attributed to the greatest variance in terms of impact on grades. As a reminder, the practice test is a compilation of past year exam questions and is an excellent tool to help orient students towards a holistic preparation for the final exam as it gives them a full-length mock exam with the same format and question weightage as the actual test.

It was also hypothesized that there would be a significant difference between the average final grades of students enrolled in the online delivery format of the course and the students enrolled in the traditional, in-person format of the course. However, based on previous findings (Harrington, 1999), students enrolled in the traditional in-person course format would perform better than the students in the online version. Instead, the results suggested that there was no significant difference in the mean scores of the two groups. This can potentially be explained by several theories.

Firstly, the cognitive flexibility theory suggests that the ability to access differing auditory and visual learning components, which is done with relative ease in online learning environments, assists with more effective learning for complex concepts (Arbaugh, 2005). Secondly, the user control theory suggests that when the learner is given more active control of their learning experience such as in terms of the study intervals, materials being used, and even session times, the learner can more effectively learn (Eveland & Dunwoody, 2001). Thirdly and perhaps most prominently, the equivalency theory (Simonson et al., 1999) could account for our null findings. It states that if the online and in-person versions of the same course are essentially designed identically (i.e., there is no disparity or difference between the two except for the mode of instruction), then the students enrolled in both versions of the course should perform equally well (Lapsley et al., 2008). Finally, previous evidence suggests declarative information, such as is found in mathematics, is well suited for online learning (Callister & Love, 2016).

It is useful to consider how the design of the course and these theories may help explain our results. The online resources and course materials were uniform for both versions of the class. They had been developed prior to the COVID-19 pandemic and therefore had been used before, during, and after the course was forced online. Additionally, this specific course on statistics for behavioral sciences is somewhat midway between declarative and application based. Hence, with all these considerations it seems reasonable that the students in the online and in-person versions of the course had comparable performances.

Lastly, we hypothesized that there would be a significant difference in the average final grades between the students enrolled in the Fall/Winter and the Spring/Summer sessions. The primary reason for this hypothesis was that the differing session lengths (8 months and 10 weeks, respectively) could create potential differences in the effectiveness of the learning and, thus, course performance. However, we found no significant difference in the two group's scores. This too can perhaps be accounted for, in part, by the equivalency theory (Lapsley et al., 2008; Simonson et al., 1999).

Given the scope of the current study (multiple years) and the size of the data set (738 students),

the power of the study is relatively high. However, there was a great deal of variability in course grades as well as the use of resources within the current course, so this large variability reduced our power. There were also extraneous factors that may also have contributed to the large error variance. For instance, after the onset of the pandemic, the university offered students an option known as credit during disruption. This allowed students to retain the credit for the course if they passed the course but did not want their course grade recorded or used in their academic average. The other option was withdrawal due to disruption, which allowed students to withdraw from the course past the allowed withdrawal period without incurring any academic penalty if the student did not pass the course. Given this, it is possible that some students may have relied on this provision and their participation in the course was affected. Several students did not write their final exam or hand in their assignments and reduced their overall engagement within the course. Due to the anonymization, we did not have data to indicate which students may not have fully engaged in the course. To control for this, we only used the data points for the students who scored above a final grade of 45 for the second and third hypothesis under the assumption that these students likely remained engaged in the course even with the opportunity to utilize these alternate grade options.

Moreover, the data were completely stripped of all identifiers and thus we did not have access to demographic information. It has been seen in past studies that age and gender had been used in similar studies (Hostager, 2014); however, our study did not utilize these avenues. Additionally, given that the data were archival and passively collected from the school's educational website we did not have any information pertaining to the actual usage of the resources. We only had information regarding the number of times each resource was accessed, and this resulted in skewed data. Moreover, having confirmation of the actual number of uses of each resource after having downloaded them would have been helpful for the present study.

FUTURE DIRECTIONS

We recommend that information be collected regarding the actual usage of the resources. Additionally, checking for student performance in quizzes and different stages of the course would be helpful in determining the effectiveness as well as the usage of the resources year-round. This would also help provide a more comprehensive model of course engagement, self-regulation, and the study habits of the students enrolled in the class. Self-report measures for student usage of the resources and the student preferences for the resources would be a helpful indicator of the actual impact of the resources from the perspective of the students. Although outside the scope of the current study, we would also like to examine potential moderators in the relationships between the use of resources with the session length, the delivery method, and course performance to see the effectiveness of the resources in various course delivery models (in-person, hybrid, synchronous online, asynchronous online, etc.). There is some evidence that synchronous teaching is more effective than asynchronous (De Felice et al., 2021); thus, we believe that if these aspects are incorporated in future studies, it would help strengthen our understanding of the factors associated with student performance. This would help educators design courses that are more conducive to better understanding and, thus, improve student performance.

CONCLUSION

Overall, we found that online tools designed to provide support for students in terms of test preparation, specifically practice questions and practice tests, significantly predicted student's final grades. This occurred independently of mode of course delivery (online versus in-person) or course duration (full year versus condensed spring term). The two modes of presentation in this case were more similar than many other courses. Both were prepared and taught by the same professor in a similar style so we cannot comment on how a more integrated, asynchronous online version that differs substantially from the in-person format would compare. However, we have demonstrated that there is evidence for the equivalency hypothesis (Lapsley et al., 2008; Simonson et al., 1999) and that online tools can be a very useful addition to courses to assist student in test preparation. As a rapidly increasing number of courses move online, it will be critical to continue developing and assessing tools and strategies to help students reach their full potential.

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