Pearson

Technical Report

A correlational study of MyLab IT in an introductory information technology course

Authors
Christine Leow
Yun Jin Rho
Amy Rutledge
Kodi Weatherholtz

Pearson Global Product Organization
Efficacy & Research
Impact Evaluation

Pearson

Table of Contents

Pearson

Executive summary

Overview of MyLab IT

MyLab IT is online courseware designed to teach students to successfully use the Microsoft Office Suite — including Microsoft Word, Excel, PowerPoint and Access. It features built-in capabilities for students to practice their skills in a simulated environment that allows them to access help, hints, and instructions in both text and video without navigating away from the environment. In this manner, it provides students with helpful scaffolding while managing their cognitive load, both of which improve learning (Sharma & Hannafin, 2007; Sweller, 1988). Furthermore, to help students focus on the software skills they need instead of on language skills they may be developing, the simulated training environment is available in several languages as well as English.

MyLab IT offers students immediate and personalized feedback so that they can home in on the exact areas where they need to strengthen their abilities. The MyLab IT assessments give students the chance to practice their skills and also to practice recalling what they have learned. Recalling what is being learned and receiving timely and personalized feedback have been shown to boost long-term retention (Hattie 2009, 2012; Karpicke & Roediger, 2008). Through these features that are based on research in learning, MyLab IT aims to prepare students for Microsoft Office proficiency throughout their college coursework and into their careers.

Intended outcome

Colleges have the challenge of educating students with vastly different levels of exposure to basic software and technology. Yet, being comfortable with applications such as Microsoft Word, Excel, and PowerPoint is a precursor to completing many college assignments. An article in *US News* highlights the nearly universal need among college students to know a word processing program, a spreadsheet program and a presentation program — the Microsoft Office suite offers the best known product, and knowledge that easily transfers to other platforms (Moll, 2014, January 27). MyLab IT offers students a rich training ground in which they can master Microsoft Office applications, helping them to succeed both in college and in work.

Performance on course exams

The goal of this study was to assess whether (and how) student use of, and performance on, MyLab IT activities related to their course performance, after accounting for prior knowledge of Microsoft Office applications. The study, therefore, covers the components of MyLab IT use that are related to student achievement across the topics covered by the product. The specific learner outcome of interest for this study was a student's average score on course exams.

Pearson

Research questions

This study of MyLab IT addressed the following research questions:

1. What is the relationship between performance as measured by MyLab IT practice exam scores and course exam scores?
2. What is the relationship between students' MyLab IT use and their course exam scores, where use is measured by:
    a. the number of unique MyLab IT activities attempted
    b. the number of repeated activities in MyLab IT
    c. the amount of time spent in MyLab IT

To answer these questions, we partnered with a mid-sized four-year university in the midwestern US to carry out a year-long study. Participants were students enrolled during the 2015–2016 academic year in one of seven sections of Business Problem-Solving with IT, an introductory information technology course. The study had 315 participants, 226 of whom had all the required data to be included in the analyses.

Key findings

The key findings addressed here are adjusted for students' MyLab IT pre-test scores and are thus net of their prior content knowledge. We discuss the findings as they pertain to both research questions.

1. **Relationship between scores in MyLab IT practice exams and average scores in course exams**.

    The results pointed to a positive and statistically significant relationship between scores on MyLab IT practice exams and average scores on course exams. Students who tended to score higher on practice exams also tended to earn a higher average score in course exams.

2. **Relationship between MyLab IT use and average scores in course exams.**

    The number of unique MyLab IT activities attempted related positively and significantly to average course exam scores, with a higher number of attempted activities generally accompanying higher average scores. For the other two usage variables included in this study — the number of activity repetitions in MyLab IT and the amount of time spent overall in MyLab IT — the pattern was in the opposite direction. Students who had a higher number of repeated activities and students who spent more time overall in MyLab IT both tended to earn *lower* average scores in course exams. For the number of repeated activities, this finding was not

statistically significant. For the overall amount of time spent, on the other hand, the result was statistically significant.

It is important to note that this study does not allow for any causal claims. Although it uncovered a number of links between MyLab IT components and average course exam scores, it cannot say whether or not any part of MyLab IT *caused* differences in average course exam scores.

Recommendations

The mixed findings in this study point to different uses for the information gathered. Specifically, the findings suggest that both high performance in practice exams and a large number of unique attempted activities in MyLab IT indicate mastery of the course material. Conversely, a large number of repeated activities and a large amount of time spent in MyLab IT may be a way to identify struggling students. It does not appear, therefore, that the three usage measures all provide a similar gauge of student engagement with MyLab IT. Rather, the number of activities attempted in MyLab IT appears to measure a different construct than the number of repeated assignments and the amount of time spent in MyLab IT.

Next steps

Future research on MyLab IT would benefit from adjusting for a range of student background characteristics. Due to limitations with the data available, this study was only able to adjust for students' MyLab IT pre-test scores. Adjusting for a wide array of student background characteristics would help untangle the unique effects of MyLab IT from the effect that factors such as student demographics and prior achievement may have on learning outcomes.

Other steps to strengthen future research include increasing the sample size beyond the 226 students, broadening the research to other colleges and universities and comparing students who used MyLab IT for their introductory IT courses to those who did not. These steps would strengthen the evidence for links between MyLab IT and learning outcomes.

Pearson

Introduction

Colleges have the challenge of educating students with vastly different levels of exposure to basic software and technology. Yet, being comfortable with applications such as Microsoft Word, Excel, and PowerPoint is a precursor to completing many college assignments. An article in *US News* highlights the nearly universal need among college students to know a word processing program, a spreadsheet program and a presentation program — the Microsoft Office suite offers the best known product, and knowledge that easily transfers to other platforms (Moll, 2014, January 27). MyLab IT offers students a rich training ground in which they can master Microsoft Office applications, helping them to succeed both in college and in work.

Overview of foundational research

Findings from more than three decades of research into intelligent tutoring systems helped inform the design of MyLab IT (e.g., Ohlsson, 1986; Anderson, Corbett, Koedinger & Pelletier, 1995). MyLab IT provides students with simulated and supported training environments that enables them to transform practice with Microsoft Office into procedural knowledge (Anderson & Schunn, 2000). Along with the training environments, MyLab IT offers personalized just-in-time feedback, helping students learn from their mistakes without putting unnecessary burden on their working memory (Sweller, 1988). These key components of MyLab IT target the learning needs of individual students, boosting their chances of success.

Key features of the research into learning design for MyLab IT

Scaffolding for learners

MyLab IT provides scaffolding for assignments in the form of help and hints within the simulated working environment. In this way, it helps students work within their zone of proximal development — the level of skill that is just beyond that which students can achieve independently — and thus pushes students toward their potential (Vygotsky, 1987). Research recommends this type of scaffolding for technology-enhanced learning (Sharma & Hannafin, 2007).

Learning environments that manage cognitive load

Psychologists use the term 'cognitive load' to refer to the amount of effort needed by one's working memory to complete a task (Miller, 1956). Mental effort that is not directly related to the learning task, but instead comes from distracting outside factors, is called extraneous cognitive load. Not surprisingly, research has demonstrated that limiting the extraneous cognitive load on students makes the learning

process more effective (Sweller, 1988). In other words, a learning environment that allows them to focus almost solely on the learning task benefits student learning.

MyLab IT helps manage cognitive load through a number of design features. First, MyLab IT offers print and video instruction within a simulated Microsoft Office environment, eliminating the extra step of leaving the Microsoft Office window to search for online resources. Additionally, the simulated Microsoft Office environment is available in multiple languages, thus reducing the cognitive load of working in a foreign language for non-native English speakers. In this manner, MyLab IT helps students focus intensively on their learning.

Assessment and recall

Research has shown that practicing a skill or knowledge alone is not enough to enable recall; learners also need to practice retrieving that skill or knowledge — the act of accessing the skill or knowledge without relying on outside sources — if they are to successfully recall it in a testing or other applied situation (Karpicke & Roediger, 2008). MyLab IT's ability to assess students' skills outside class provides them with frequent opportunities to retrieve what they have practiced. This feature of MyLab IT thus reinforces long-term recall and a student's ability to apply their skills outside the learning environment.

Feedback

An important way in which MyLab IT benefits student learning is by providing frequent, immediate and personalized feedback, which has been shown to support long-term retention as well as motivation and confidence (Hattie 2009, 2012). In fact, timely feedback adapted to individual students through learning technology has been found to be as beneficial to learning as human tutors (VanLehn, 2011). With MyLab IT, students receive detailed reports informing them of what was incorrect and also helping them further develop their understanding. Moreover, MyLab IT allows instructors to easily check on student progress, giving them an important tool for adjusting their instruction to the needs of individual students in their classes.

Description of MyLab IT

MyLab IT is online courseware designed to teach students to successfully use the Microsoft Office Suite — including Microsoft Word, Excel, PowerPoint and Access. It features built-in capabilities for students to practice their skills in a simulated environment that allows them to access help, hints, and instructions in both text and video without navigating away from the environment. In this manner, it provides students with helpful scaffolding while managing their cognitive load, both of which improve learning (Sharma & Hannafin, 2007; Sweller, 1988). Furthermore, to help students focus on the software

skills they need instead of on language skills they may be developing, the simulated training environment is available in several languages as well as English.

MyLab IT offers students immediate and personalized feedback so that they can home in on the exact areas where they need to strengthen their abilities. The MyLab IT assessments give students the chance to practice their skills and also to practice recalling what they have learned. Recalling what is being learned and receiving timely and personalized feedback have been shown to boost long-term retention (Hattie 2009, 2012; Karpicke & Roediger, 2008). Through these features that are based on research in learning, MyLab IT aims to prepare students for Microsoft Office proficiency throughout their college coursework and into their careers.

The present study

This study of MyLab IT had two main goals. First, it sought to determine whether and how student performance in MyLab IT practice exams was related to their scores in course exams administered by the instructor. The MyLab IT practice exams serve as a low-stakes measure of student performance within the courseware.

The study's second aim was to determine whether and how students' MyLab IT use was related to their course exam scores. For this study, use includes the total time each student spent on MyLab IT activities, the number of MyLab IT activities each student attempted, and the number of repeated activities in MyLab IT for each student. These usage metrics were intended as proxy measures of students' level of engagement within MyLab IT[1]. So, in determining whether and how use was related to course exam scores, we sought to examine the link between students' level of engagement with MyLab IT and their performance on the course.

Specifically, the research questions were:

3. What is the relationship between performance as measured by MyLab IT practice exam scores and course exam scores?
4. What is the relationship between students' MyLab IT use and their course exam scores, where use is measured by:
    a. the number of unique MyLab IT activities attempted

[1] We do not mean to imply that course engagement is reducible to relatively simple measures of courseware use. Indeed, course engagement is a complex and multidimensional phenomenon. Nonetheless, the usage variables that we derived from the available data provide an important, albeit partial, window onto student engagement with course content.

b. the number of repeated activities in MyLab IT

c. the amount of time spent in MyLab IT

In answering these questions, we ideally would have wanted to control, or statistically adjust, for the contribution that other outside factors make to exam scores, such as students' demographic characteristics and their prior achievement in school (such as their prior GPA or SAT/ACT scores). Doing so helps ensure that the differences in course exams between students are attributable to the measures of interest — MyLab IT practice exam scores and usage — and not these outside factors.

Unfortunately, we could not obtain data on demographic characteristics or on prior achievement in school. Student scores in MyLab IT pre-tests, however, were available and were included in the analyses reported here. All findings, therefore, control for students' knowledge of a topic before covering that topic in the course.

We hypothesized that both MyLab IT practice exam scores, which gauge student performance within MyLab IT, and their amount of use of MyLab IT, which should reflect their engagement with the courseware, would relate positively to their exam scores for the course. In other words, we expected that students with higher practice exam scores and students who had higher levels of use would earn higher scores in course exams.

We expected higher scores on practice exams to be linked to higher scores in course exams because high scores in practice exams would signal greater understanding of the course material, which would in turn be reflected in higher course exam scores. Underlying the hypothesis for MyLab IT use was the assumption that greater use would indicate a higher level of engagement within MyLab IT; a higher level of engagement would result in more exposure to the topics presented in MyLab IT, in turn leading to higher grades in course exams.

Pearson

Method

This study used a correlational design to answer the research questions. For this approach, students' MyLab IT use and performance metrics were correlated to their academic achievement in the course, while taking into account prior content knowledge, a student-level factor that was likely to affect achievement.

Participants

Participants in this study were students at a mid-sized four-year university in the midwestern US, who were enrolled during the 2015–2016 academic year in Business Problem-Solving with IT, an introductory information technology course. Students were recruited from seven sections of this course, all of which used MyLab IT for Office 2013: Exploring Series + Visualizing Technology, 4e.

A total of 315 students were enrolled in one of these seven course sections (see Table 1). Of these enrolled students, 226 students provided all data sources needed to calculate the outcome and predictor variables of interest (see details that follow). This group of 226 students served as the analytic sample. For the remaining students (*n* = 89), one or more critical data source was unavailable, and these students could not be included in the analysis.

Table 1: Number of students enrolled in each section for Business Problem-Solving with IT

Course Title in MyLab IT	Number of Students
MIS 100 — Fall 2015 41054 920	47
MIS 100 — Fall 2015 41055 1040	45
MIS 100 — Fall 2015 41220 OL	46
MIS 100 Winter 2016 10692 MWF Noon	45
MIS 100 Winter 2016 11713 MWF 10:40	44
MIS 100 Winter 2016 13189 MW 9AM	43
MIS 100 Winter 2016 Online 11659	45

Data collection

All the data for this study came directly from MyLab IT. As MyLab IT is online courseware, it stores user data, including student scores on all MyLab IT activities (pre-tests, simulation-based training assignments and practice exams), as well as the amount of time spent and the number of attempts made on each activity. We extracted this student-level MyLab IT use and performance data for analysis purposes.

For this study, learner outcome data was also available via MyLab IT because the course instructor implemented all course exams using MyLab IT. This allowed us to link student-level data on MyLab IT

use and performance with student course performance data.

Measures

Outcome measure: average course exam score

The learner outcome measure of interest was students' average score in course exams. Students completed three exams throughout the course. These exams were evenly spaced over the semester, roughly once a month (at the end of September, October and November for students enrolled in course sections during Fall 2015, and at the beginning of February, March and April for students enrolled in Winter 2016 sections). Taken together, student performance across these course exams provides a holistic view of achievement with respect to primary course content.

The decision to use average course exam scores as the learner outcome metric was based on data availability. Final exam scores and final course grades were not available for this study, and we could not use course grades or course pass/fail as learner outcome metrics.

MyLab IT performance

The measure of performance on MyLab IT was students' average score in MyLab IT practice exams.

MyLab IT use

Three MyLab IT use variables, that can also serve as proxy measures of student engagement, were derived for each student: (i) the total time (in hours) spent on MyLab IT activities; (ii) the total number of unique MyLab IT activities attempted, and (iii) the total number of activity repetitions in MyLab IT. We discuss the rationale for each of these measures in turn.

MyLab IT activities were a major source of course content and course assignments. Therefore, more time spent on the platform over the course of the semester can reasonably be interpreted as higher overall course engagement. We, therefore, calculated each student's total time on MyLab IT by adding up the duration of all activity sessions for each student over the course of the semester.

It should be noted that some individual session durations were extremely long: 10+ hours and, in rare cases, several days. These long sessions were likely the result of either (i) system logging errors, or (ii) students staying logged on while not actively using the courseware. In either case, these atypically long session times do not reflect student engagement with course content. Therefore, when calculating each student's total on-platform duration for the course, platform sessions with atypically long durations were excluded. The exclusion criterion was MyLab IT session times greater than two standard deviations above the mean duration for the corresponding MyLab IT activity type.

One limitation of this time-based proxy for engagement is that students with relatively small on-platform duration totals might not be inherently low in terms of course engagement. Take, for example, a hypothetical student who is highly engaged but who also tends to be a fast learner. This

student could complete course assignments at a faster pace, on average, than their peers, resulting in a relatively low on-platform duration total for the course, despite being highly engaged and working through all assigned course material. Thus, while time-on-task provides useful information about student behavior and use of MyLab IT, this measure conflates a number of factors, including course engagement and student ability and need.

We, therefore, derived two additional MyLab IT use variables to obtain a more holistic view of student course behavior. The first measure — the number of unique MyLab IT activities attempted — indicates the amount of course content each student engaged with via the MyLab IT courseware. The second measure — the total number of repeated MyLab IT activities — indicates, at least in part, willingness to engage with difficult course content. Note, though, that since a student is most likely to repeat an activity in the event of low performance, the total number of repeated activities per course is also partly an index of the level of challenge or struggle with the material.

Statistical controls: prior content knowledge

When using a correlational (i.e., non-experimental) design to study the relationship between a learning intervention and learner outcomes, as in the present case, it is ideal to statistically adjust for the contribution of outside factors that tend to correlate with learner outcomes, such as demographic background and prior achievement (e.g., cumulative GPA or GPA across previous courses related to the current course). This method of statistical adjustment in non-experimental designs helps ensure that observed differences in learner outcomes are attributable to the measures of interest (in this case, MyLab IT use and performance) and not to external factors. Unfortunately, as indicated above, we were unable to obtain student-level demographic and prior achievement data to use as statistical controls.

Therefore, to make this study as conservative as possible given the available data, we derived a statistical control for prior content knowledge using performance on a subset of MyLab IT activities. Specifically, this measure was average performance on MyLab IT pre-tests.

Students completed multiple MyLab IT pre-tests during the course (median = 7; see Figure 1). These pre-tests occurred at roughly regular intervals throughout the semester, corresponding to the beginning of new content areas (see Figure 2). Performance on individual pre-tests measures student knowledge and abilities related to specific aspects of Microsoft Office software prior to receiving training on that topic. Therefore, we consider average performance across pre-tests to provide a reasonable and holistic measure of prior knowledge of the course content. By including this variable in the analysis of learner outcomes, we were able to statistically adjust for one source of individual differences across students that contributes to their achievement. The variable should therefore be considered a proxy for student prior achievement.

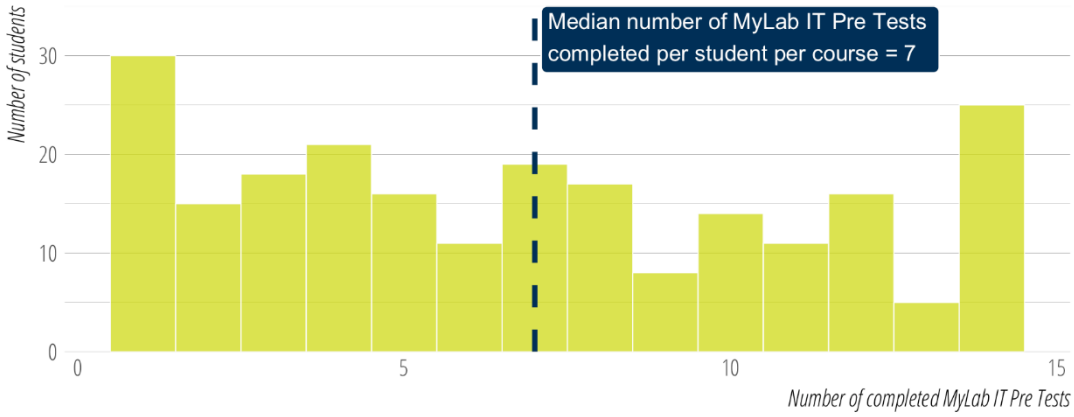

Figure 1: Distribution of unique MyLab IT pre-tests completed per student

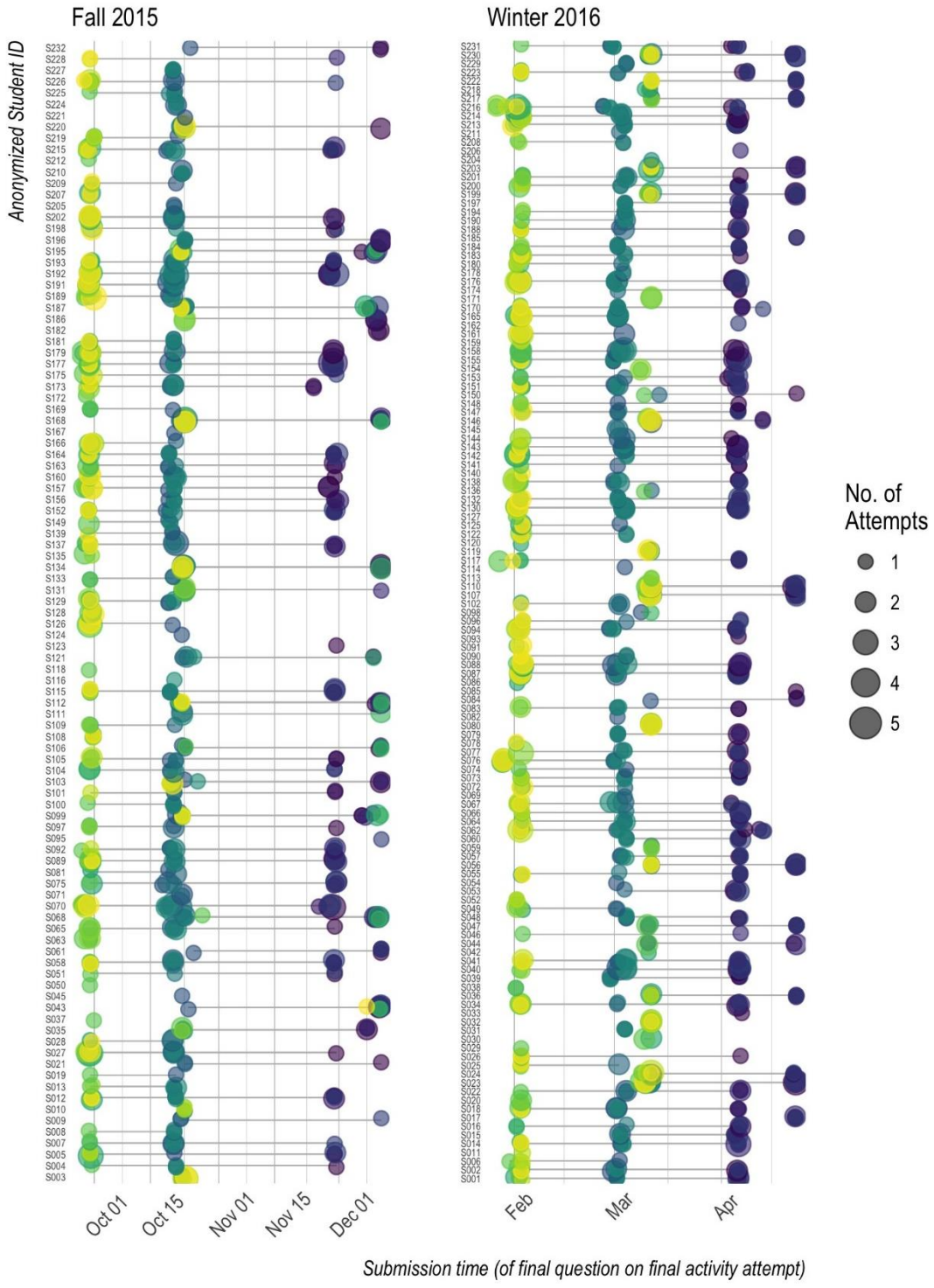

Figure 2: MyLab IT pre-test submission times for each student throughout the semester. Color indicates pre-test activity ID. Size indicates the number of times a student attempted each MyLab IT pre-test, which could be completed more than once.

Analysis procedure

As indicated above, the learner outcome metric of interest in this study was the students' average score in course exams. When the dependent variable in a regression analysis is represented as proportion correct (or percentage correct), as in the current case, the appropriate statistical approach depends on the distribution of the dependent variable. The simplest approach is to fit a linear regression model. However, this approach is only appropriate if the proportion data are distributed within the interval of 0.2 to 0.8 (or 20% to 80% for percentage correct). If this condition is not met — that is, if observed data is concentrated at or near the extremes of 0 and 1 (or 0% and 100%) — linear regression is not appropriate. The reason is that linear regression assumes continuous data, rather than bounded data, so when proportion data is concentrated near the bounds of 0 and 1, an analysis using linear regression can predict impossible values that are less than 0 or greater than 1. In cases where data is distributed between 0 and 1, with clustering near the extremes, it is necessary to use a regression approach that accounts for the bounded nature of the data, such as beta binomial regression.

Figure 3 shows the distribution of average course exam scores for the students in this study. The vast majority of the data falls in the range of 20% to 80%. However, since a small fraction of the observed average course exam scores fall outside this interval, the data does not unambiguously meet the criterion for using linear regression as an analysis method. Despite some of the data falling outside the 20–80% interval, however, none of the data is at the extremes of 0% or 100%. Given this distribution, it is a priori likely that a linear regression model and a more complicated beta binomial model that accounts for the boundedness of the dependent variable will yield qualitatively similar results.

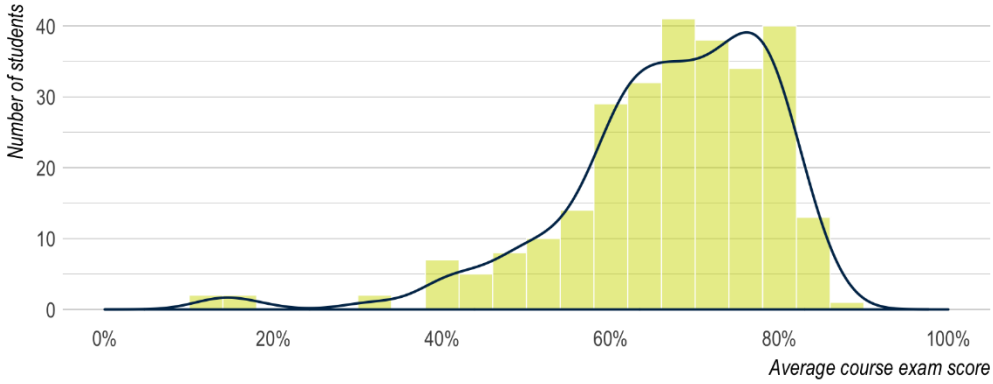

Figure 3: Distribution of students' average course exam scores

Given the distribution shown in Figure 3, we employed the following analysis strategy. In the interests of conducting a conservative assessment of the factors affecting learner outcomes, student course exam scores were analyzed using beta binomial regression. However, since beta binomial regression is relatively more complicated than linear regression, and hence more difficult to reason about, we

additionally conducted corresponding linear regression analysis. For reporting, we prioritize accuracy but also simplicity and interpretability. Therefore, if the linear regression and beta binomial regression analyses provide qualitatively similar results, we report the linear regression analysis. We intend only to report results from the conservative beta binomial model in the body of this report for cases where the findings from the two approaches differ.

Pearson

Results

The primary goal of this study was to assess the relationship between students' use of and performance on MyLab IT activities and learner outcomes. Before assessing this relationship, we first present a descriptive overview of key course statistics: enrollment, course completion rates, assignment completion rates and course pass rates (estimated from available data since final grades were not available). Next, we present a descriptive overview of students' use of and performance on MyLab IT activities. We then address the primary goal of this study by using a high-level correlational analysis to assess the relationships among MyLab IT performance and use on the one hand and student performance in course exams on the other, after controlling for students' prior content knowledge.

Descriptive overview of course statistics

Course completion rates

The majority of learners enrolled in the course completed the course. In this course, the instructor assigned individual activities within MyLab IT as practice and homework exercises and also combined MyLab IT resources to generate course exams to assess students' programming skills. Using information about the number of assignments completed by students, we were able to derive a proxy measure of course completion from the available data. This derived measure was whether students completed all course exams. For the purposes of this study, we considered students to have completed the course if they completed all course exams. Of the 315 students who enrolled in the course, 12% (39) dropped out of the course before the first exam, 16% (49) did not complete all course exams, and 72% (227) completed all course exams and are designated as having completed the course.

Assignment completion rates

A majority of the students that remained enrolled in the course completed course assignments. From among the 227 students that completed the course, 85% completed at least 65% of all non-extra-credit course assignments.

Course pass rates

For those students who completed the course, 78% successfully earned passing scores. *We* derived a proxy measure of whether students passed the course based on the scores for course exams. Specifically, students were counted as having passed the course if they completed all course exams and averaged a score of 60% or higher across all exams. Using these criteria, out of the original 315 students that enrolled in the course, 12% (39) dropped out of the course before the first exam, 16% (49) did not complete all course exams, 57% (178) earned a passing grade on the course and 15% (49) failed the

course. Focusing only on those students who remained enrolled and completed the course (227 students), the pass rate was 78%.

Descriptive overview of MyLab IT use and performance

Total time on MyLab IT activities

Figure 4 shows the distribution of students' total time on MyLab IT activities across the semester. The median total time was 15 hours, with the vast majority of students (87%) spending between 10 and 25 hours in total. Since the semester was 15 weeks long, this translates to 87% of students averaging between 40 minutes and 1 hour and 40 minutes of MyLab IT use per week.

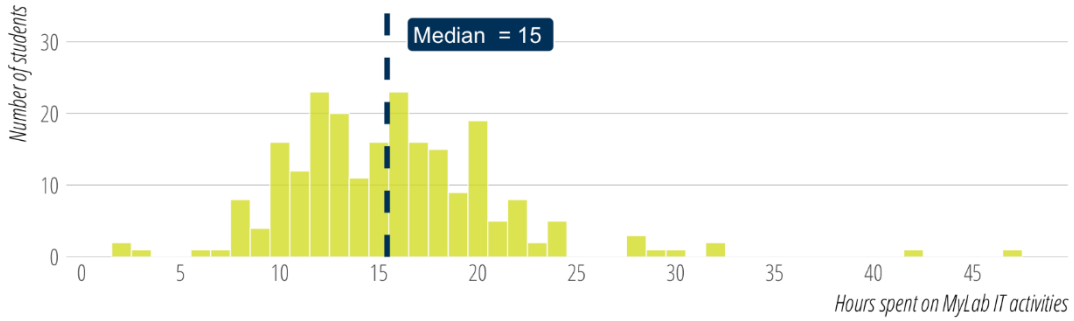

Figure 4: Distribution of time spent on MyLab IT activities, after excluding outliers

Activity attempts and activity repetitions

Figure 5 gives an overview of students' use of MyLab IT. The left panel shows the distribution of unique MyLab IT activities attempted per student (median: 23; range: 5–47). The right panel shows the total number of MyLab IT activity repetitions per student (median: 2; range: 0–36).

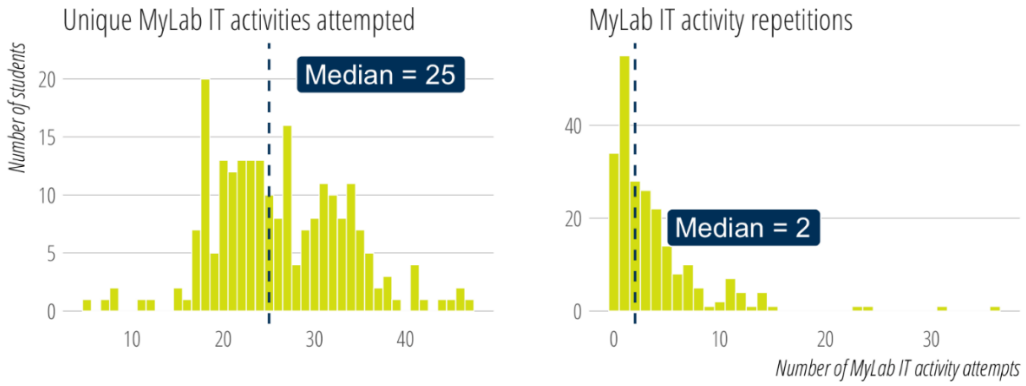

Figure 5: Distribution of MyLab IT activity attempts: unique activities attempted (left), and total number of activity repetitions (right)

Relationship between course exam scores and MyLab IT performance and use

To assess the relationship between learner outcomes and MyLab IT performance and use, students' average course exam scores were analyzed as a function of their (i) average scores on MyLab IT practice exams; (ii) total number of unique MyLab IT activities attempted; (iii) total number of MyLab IT activity repetitions, and (iv) the total time (in hours) spent on MyLab IT activities. Additionally, students' average score on MyLab IT pre-tests was included as a covariate to statistically control for prior content knowledge. Pre-tests occurred at the beginning of new content areas. All predictor variables were centered at the grand mean.

Three regression analyses were conducted: (i) a single-level linear regression analysis, with students' average course exam grades scored as average percentage correct; (ii) a corresponding beta binomial regression (with the dependent variable scored as average proportion correct), and (iii) a multi-level linear regression analysis, containing the predictors above as fixed effects, along with a random intercept for course section. Results were qualitatively similar across analyses (see Table 2 in this section and Tables 3 and 4 in the Appendix). For clarity and simplicity, we present only results from the multi-level linear regression analysis in the remainder of this section with results from additional analyses in the Appendices. All statistically significant findings reported use a 0.05 significance level.

The multi-level linear regression model reported below includes the following terms:

Fixed effects:

- average scores on MyLab IT pre-tests (control variable)
- average scores on MyLab IT practice exams
- total number of unique MyLab IT activities attempted
- total number of MyLab IT activity repetitions
- total time (in hours) spent on MyLab IT activities

Random intercept:

- course section (7 levels)

Average performance in course exams

The average course exam score for an average student (i.e., a student with average prior content knowledge and average MyLab IT performance and use) was 66.7%. Since all predictor variables were centered at the mean, the coefficient estimate for the intercept represents the average of the response variable across students.

Effect of prior content knowledge

There was no significant relationship between prior content knowledge — as measured by their average score on the MyLab IT pre-tests that occurred at the beginning of content — and average course exam scores.

Effects of MyLab IT performance and use

Average MyLab IT practice exams score

After statistically controlling for prior content knowledge, there was a significant and positive relationship between students' average MyLab IT practice exam scores and their average course exam scores. Specifically, for every increase of a percentage point in students' average MyLab IT practice exam scores, average scores on course exams increased by 0.22 percentage points. See Figure 6.

Total number of unique MyLab IT activities attempted

Students who attempted a greater number of unique MyLab IT activities generally earned higher course exam scores overall. Specifically, for each additional unique MyLab IT activity attempted, average course exam scores increased by 0.77 percentage points. See Figure 6. To express this result in a form that makes it more relevant and accessible to students: attempting an additional seven unique activities (since 0.77% * 7 activities = 5.4%) is associated with an increase in course exam score corresponding to half a letter grade (i.e., 5%).

Number of repeated MyLab IT activities

The relationship between the number of repeated activities and course exam scores was not statistically significant at an alpha level of .05 (p = .06). Students who repeated a greater number of MyLab IT activities tended to earn somewhat lower average course exam scores. The effect suggests that for each additional activity repeated, average course exam scores decreased by 0.33 percentage points. See Figure 6. Although this finding runs contrary to our hypothesis and was not statistically significant, we nevertheless report it here because its p-value was very close to the threshold for statistical significance.

Total time using MyLab IT

Students who spent longer on MyLab IT overall tended to earn lower average course exam scores. For each additional hour spent on MyLab IT activities, average course exam scores decreased by 0.64 percentage points. The direction of this effect is not surprising. Although total time on task may be seen as a measure of course engagement, it can also serve as an index of student ability (i.e., struggling students are likely to average longer times overall). See Figure 6.

Pearson

Table 2: Summary of fixed effects estimates from multi-level linear regression analysis of average course exam scores

Term	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	66.68	1.51	44.19	< .001
Average MyLab IT pre-test score (prior knowledge)	-0.04	0.03	-1.57	0.12
Average MyLab IT practice exam score	0.22	0.04	5.35	< .001
Number of unique MyLab IT activities attempted	0.77	0.13	5.91	< .001
Number of MyLab IT activity repetitions	-0.33	0.17	-1.88	= 0.06
Total time on MyLab IT (hours)	-0.64	0.18	-3.50	< .001

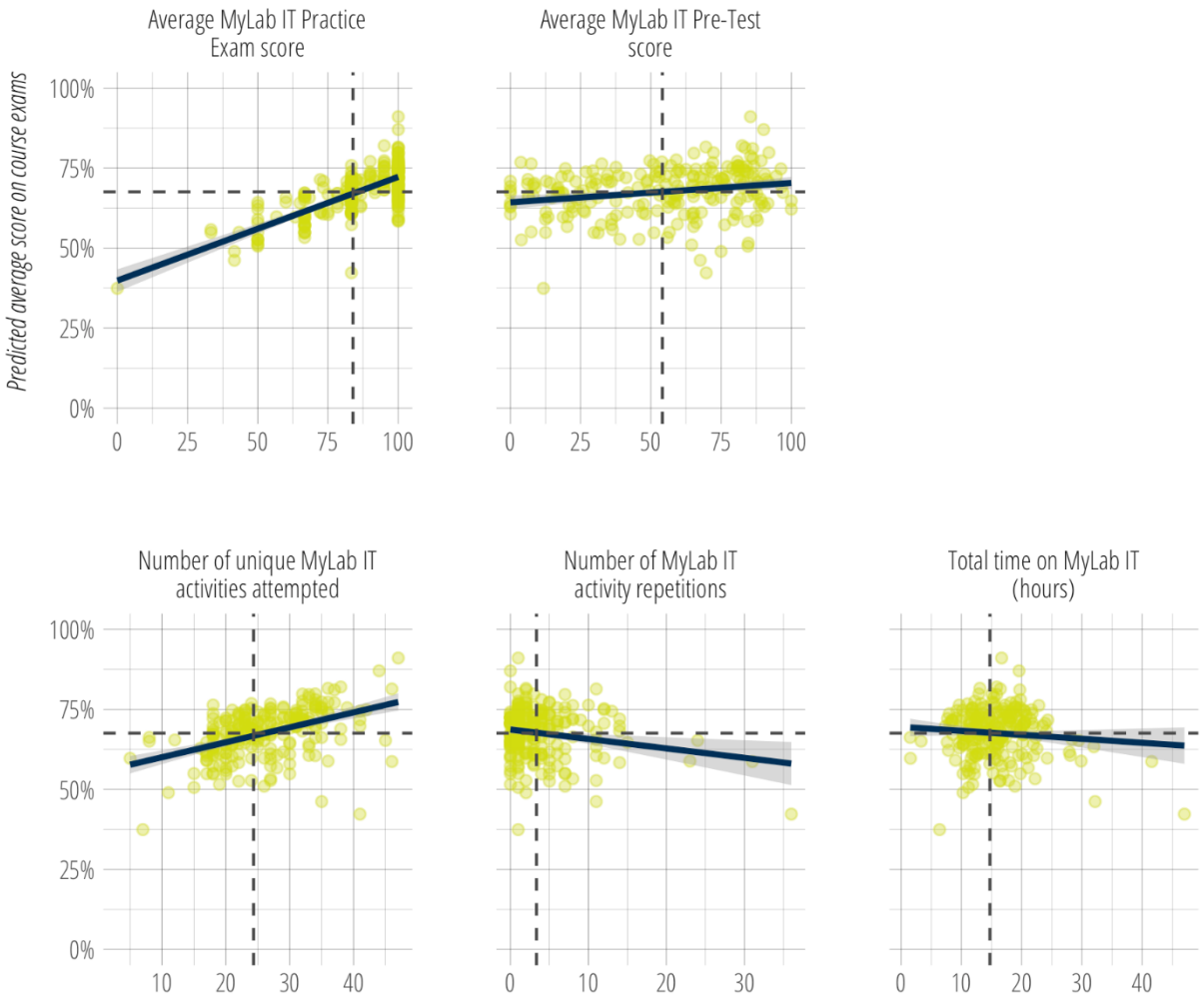

Figure 6: Relationship between students' average course exam scores and each of the MyLab IT performance and use variables included in this study

Random effect of course section

In addition to the fixed effects reported above (see Table 2), the multi-level regression analysis included random intercepts for course section. Figure 7 shows the estimates for these by-section random intercepts, plotted as the difference in students' average course exam scores in each section relative to the mean across sections. To interpret this plot, note that the overall model intercept was $b_{Intercept}$ = 66.7 (see Table 2), indicating that, across course sections, average course exam score was 66.7%. This overall estimate is plotted as zero in Figure 7 to highlight by-section deviation from the overall mean.

Several aspects of this figure are worthy of note. First, of the seven course sections included in this study, average course exam scores were highest among students enrolled in the Fall 2015 Online section — students in that section earned an average course exam score that was 5.2 percentage points higher overall (or 71.9% on average). In contrast, students who enrolled in the two in-person sections that were offered during Fall 2015 averaged the lowest scores in course exams: 3.3 and 5.3 percentage points lower overall, respectively (or 63.4% and 61.4% on average).

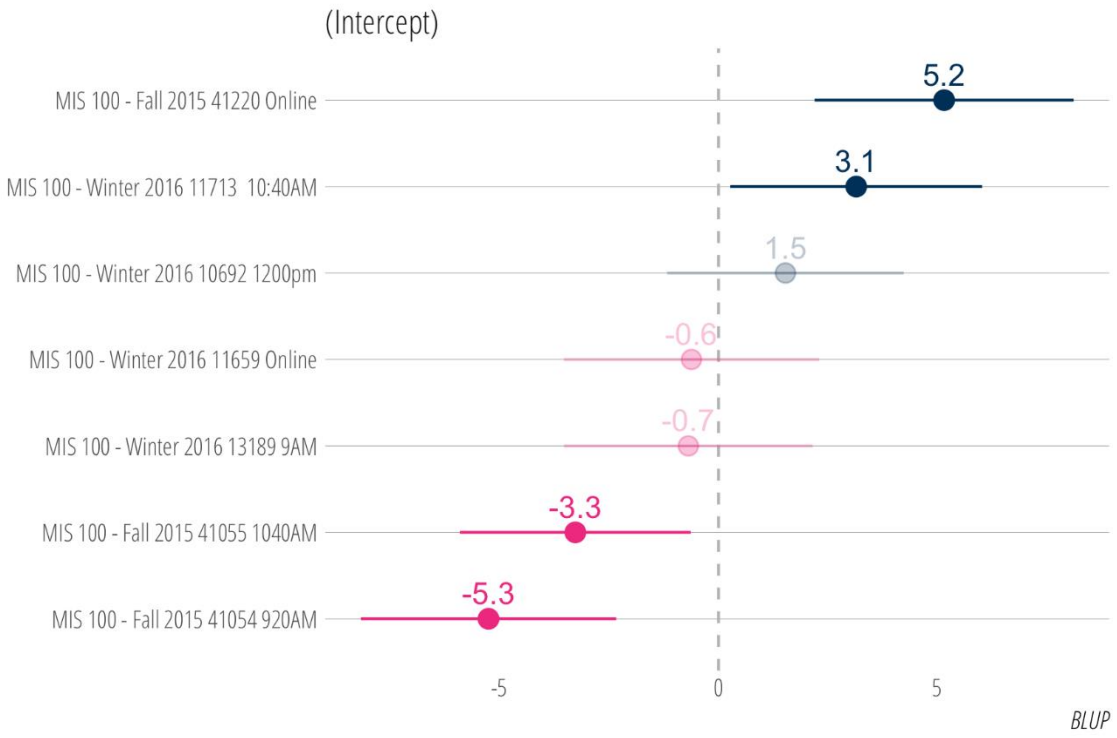

Figure 7: Point estimates and 95% confidence intervals for by-section random intercepts. The dashed line at zero indicates overall model intercept, $b_{Intercept}$ = 66.7 (see Table 2). Points indicate the degree of difference between average course exam scores in each section relative to model intercept

Pearson

Discussion

The aims of this study were to (i) examine the relationship between MyLab IT practice exam scores and scores on exams administered by the instructor and (ii) examine the relationship between MyLab IT use and instructor-administered exam scores. We sought to uncover how student performance in a practice setting within MyLab IT and the level of engagement with MyLab IT were each linked to overall student performance for the course. The data for this study comes from use and performance records within MyLab IT for students enrolled in the introductory IT course Business Problem-Solving with IT at a mid-sized four-year university in the midwestern US during the 2015–2016 academic year..

Since we conceptualized MyLab IT practice exam scores as a gauge of performance within MyLab IT and use as a proxy of engagement with MyLab IT, we expected both of these factors to relate positively to exam scores for the course. Our hypotheses were, in some cases, supported by the results of the analyses. Specifically, after adjusting for students' prior content knowledge as measured by their average score on the MyLab IT pre-tests that preceded work in MyLab IT for each topic, we found that both MyLab IT practice exam scores and the total number of unique MyLab IT activities attempted related positively to course exam scores. In other words, students with higher MyLab IT practice exam scores and students who attempted a larger number of MyLab IT activities tended to earn higher scores in course exams.

However, two of the main findings for this study ran counter to our hypotheses. After adjusting for average pre-test scores, the number of repeated activities in MyLab IT and the amount of time spent overall in MyLab IT both related *negatively* to course exam scores, in that students with either a larger number of repeated activities or a greater amount of time spent in MyLab IT tended to earn lower scores in course exams. For time spent in MyLab IT, this result was statistically significant whereas for the number of repeated activities, the reported effect was not statistically significant. Nevertheless, both results merit attention.

We conceptualized all three of the use measures we examined — the number of unique MyLab IT activities attempted, the number of repeated activities in MyLab IT and the total amount of time spent in MyLab IT — as a proxy of gauging student engagement with MyLab IT. Yet both the number of repeated activities and the total time spent may reflect a completely different factor: the level of challenge presented to students by the course material. Repeating an activity in MyLab IT may signal that a student failed to master the knowledge on the first attempt. Similarly, students who struggle to learn the course material may seek out extra exposure to the activities and content in MyLab IT, which would be reflected in the total amount of time spent in MyLab IT.

Limitations

The study's findings should be viewed in light of its limitations. First, the study's correlational design does address whether MyLab IT performance and use *caused* the differences in course exam scores observed or whether another outside factor was at play. A more rigorous design would compare the performance of students using MyLab IT to students not using MyLab IT, and students would either be randomly assigned to treatment condition or would be matched to students in the other group on important background characteristics, such as prior achievement and demographic factors. Additionally, whereas generally correlational studies adjust for multiple background characteristics such as student demographics and prior academic achievement, this study could only adjust for average pre-test scores in MyLab IT, as other student background measures were not available. Another consideration is the study's sample, which was relatively small and from a single university. Therefore, the findings are not likely to reflect the experience and performance of the whole of MyLab IT students across all colleges and universities.

Implications of findings for product implementation and further research

Although the main finding for performance was positive, with higher practice test scores in MyLab IT linked to higher course exam scores, the findings on MyLab IT use were mixed. On the one hand, greater use in the form of a larger total number of unique activities attempted was associated with higher course exam scores. On the other, a more time using MyLab IT and a greater number of repeated MyLab IT activities both related to *lower* course exam scores, with a statistically significant result for the former and a nonsignificant result for the latter. As discussed above, these different variables, though all derived from MyLab IT use, may actually be measuring different constructs.

Future research with MyLab IT products could look for similar patterns across the different types of use variables, which would imply that the variables are really measuring the two separate constructs of engagement and the level of challenge posed to students by MyLab IT materials.

Future research with MyLab IT could also specifically incorporate larger sample sizes, branching out to additional colleges and universities, adjusting for a wider array of student background characteristics, and including both a treatment group that uses MyLab IT and a comparison group that does not. Larger sample sizes would allow for a larger level of certainty for the findings, as would conducting studies at a larger number and greater variety of types of colleges and universities. Conducting analyses that adjust for a wider array of student background characteristics in correlational studies would help untangle the unique effects of MyLab IT from factors such as the effect of student demographics and prior achievement on learning outcomes. Similarly, research designs that include both a treatment group of MyLab IT users and a comparison group of non-users would address more directly gains in learning outcomes that could be traced back to MyLab IT specifically.

References

Anderson, J. R., Corbett, A., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *Journal of the Learning Sciences, 4*(2), 167–207.

Anderson, J. R. & Schunn, C. D. (2000). Implications of the ACT-R learning theory: No magic bullets. In R. Glaser, (Ed.), *Advances in instructional psychology: Educational design and cognitive science* (Volume 5), pp. 1-34. Mahwah, NJ: Lawrence Erlbaum Associates.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York, NY: Routledge.

Hattie. J. (2012). *Visible learning for teachers: Maximizing impact on learning*. New York, NY: Routledge.

Karpicke, J. D. & Roediger, H. L., III (2008). The critical importance of retrieval for learning. *Science 319*, 966–968.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81–97.

Moll, M. (2014, January 27). 5 must-have tech skills for college students. US News. Retrieved from https://www.usnews.com/education/blogs/college-admissions-playbook/2014/01/27/5-must-have-tech-skills-for-college-students

Ohlsson, S. (1986). Some principles of intelligent tutoring. *Instructional Science, 14*(3), 293–326.

Sharma, P., & Hannafin, M. J. (2007). Scaffolding in technology-enhanced learning environments. *Interactive Learning Environments, 15*(1), 27–46.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257–285.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist, 46*(4), 197–221.

Vygotsky, L. S. (1990). *The collected works of L. S. Vygotsky.* R. W. Rieber (Ed.). New York: Springer.

Pearson

Appendix: Additional statistical tables

Table 3: Summary of results from linear regression (OLS) model predicting average course exam scores (percent correct) based on students' MyLab IT use and performance, while controlling for prior content knowledge

Variable	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	66.587	0.673	98.99	< .001
Average MyLab IT practice exam score	0.264	0.042	6.35	< .001
Average MyLab IT pre-test score	-0.036	0.027	-1.34	0.18
Number of unique MyLab IT activities attempted	0.767	0.140	5.48	< .001
Number of MyLab IT activity repetitions	-0.393	0.187	-2.10	< .05
Total time on MyLab IT (hours)	-0.681	0.196	-3.48	< .001

Table 4: Summary of results from beta binomial regression model predicting average course exam scores (proportion correct) based on students' MyLab IT use and performance, while controlling for prior content knowledge

Variable	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	0.692	0.030	22.99	< .001
Average MyLab IT practice exam score	0.012	0.002	6.49	< .001
Average MyLab IT pre-test score	-0.002	0.001	-1.27	0.20
Number of unique MyLab IT activities attempted	0.035	0.006	5.38	< .001
Number of MyLab IT activity repetitions	-0.017	0.008	-1.98	< .05
Total time on MyLab IT (hours)	-0.030	0.009	-3.43	< .001