

# TEACHING QUANTITATIVE COURSES ONLINE: ARE LEARNING TOOLS OFFERED BY PUBLISHERS EFFECTIVE?

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## ABSTRACT

*In recent years, online teaching has become extremely popular. Most institutions of higher learning are offering online courses in almost every field of study. Teaching any course online is challenging, but teaching quantitative courses, such as operations management, management science, statistics, and others, have added a more challenging dimension to online teaching. Publishers have been assisting professors of quantitative methods courses by developing various teaching and evaluation tools. This study explores one such publisher's tool, Quiz Me Mastery Points, of Pearson's MyOmLab. The performance of students on their examinations and the Mastery Points they earned through the Quiz Me feature were compared, and it was determined that there was a significant correlation between the two.*

*Keywords: Online teaching, Quantitative courses, Quiz Me Mastery Points, MyOmLab*

## INTRODUCTION

In the last decade online teaching and learning has become the norm in many institutions of higher learning. Numerous institutions are offering online courses both nationally and internationally. The Online Consortium tracks online education in the United States and releases an annual report entitled The Online Report Card. The most recently released report (Allen & Seaman, 2016) showed there were more than 5.8 million students in the United States enrolled in one or more online courses in the fall of 2014. This constitutes 28.4% of all student enrollment. The report further stated that many academic leaders (63.31% in 2015) strongly believe online learning is a critical component of their long-term strategy. It also stated that 77.14% of the chief academic officers in 2015 rated the learning outcome of online education as good as or better than face-to-face. However, an alarming finding was that only 29.1% of the chief academic officers believed their faculty accepted the value

and legitimacy of online education. These findings, along with historic trends, reveal a mismatch between the growth in student demand for online course offerings and the hesitancy of faculty to buy into the efficacy of online teaching. Reconciling this mismatch is critical to realizing the full potential of the online classes that the students are increasingly expecting.

Data were collected from students in an online MBA program (Kim, Liu, & Bonk, 2005) through semistructured, one-on-one interviews, surveys, and in-person focus group interviews. It was determined that over 70% of those surveyed described their online learning experience in a positive manner, and about 93% of the respondents were satisfied with the quality of their online courses. A study that conducted one-on-one interviews with fifteen experienced e-learning instructors (Bailey & Card, 2009) identified eight effective pedagogical practices for effective online teaching: fostering relationships, engagement, timeliness, communic-

ation, organization, technology, flexibility, and high expectations. The challenge of understanding and integrating these eight facets of effective online teaching was a possible reason for the hesitancy within the ranks of the faculty to embrace online teaching (Allen & Seaman, 2016).

Two key obstacles for effectively teaching an online class were identified as meeting the student's core educational needs and maintaining a sense of teaching presence (Carliner & Shank, 2016). To meet students' core needs, instructors must draw on a variety of tools and strategies, which various textbook publishers are increasingly offering. Among them are MyLab by Pearson, MindTap by Cengage, and Wiley Plus. Effective use of these tools can bridge the gap between student expectations and the hesitancy of faculty to meet the core needs of students.

This paper explores and evaluates the Quiz Me Mastery Points of Pearson MyOmLab and determines whether this feature can bridge the gap between faculty hesitation and student demand for online offerings. We studied students' performances on tests and the Mastery Points they earned through the Quiz Me feature and found that there is a significant correlation between the two. First, we present a comprehensive review of the current literature that deals with various challenges faced by online course offerings and what pedagogical responses were likely to be successful. Then, in the methodology of the study we investigate the performance of 174 students over four semesters (3,000 individual assessment scores). Next, we give the results of the analysis and we identify factors that improve or do not have an impact upon student performance. Finally, we propose possible avenues for future research.

## LITERATURE REVIEW

In recent years, blended teaching and learning, which includes online versus face-to-face, has grown immensely; yet, the literature is not as abundant as one would expect. Not only has learning been under scrutiny, but some studies have focused on other students' and teachers' viewpoints such as satisfaction, performance, professor-student interaction, and a host of other facets of teaching and learning. Smith and Bryant (2009) observed the paucity of literature on teaching case-based statistics classes and offer useful

tips for guiding online discussions. Dotterweich and Rochelle (2012) also lamented the paucity of research examining student characteristics and factors leading to successful outcomes. They studied three modes of delivery (online, instructional television, and traditional classroom) with three groups of students with similar GPAs prior to taking their statistics courses. They found online students were significantly older and more likely to repeat the course and have earned more credit hours prior to enrolling. They also found that GPA and percentage of absences were highly significant predictors of course performance. On the suitability of online delivery for quantitative business courses, specifically business statistics and management science, research findings suggest that features involving professor-student interaction are the most useful, features promoting student-student interaction are the least useful and discussion forums are of limited value in learning quantitative content (Sebastianelli & Tamimi, 2011). Katz and Yablon (2003) examined students' academic performance in a required first-year university internet-based Introduction to Statistics course and the psychopedagogical variables that contributed to students' online learning as compared to the learning of students who participated in a traditional lecture-based course. They found no difference in the performance levels achieved by students of the two groups. In addition, they found that participation in the online course improved psychopedagogical attitudes towards online learning despite the initial misgivings of the participants in. A meta-analysis of performance differences between online and face-to-face undergraduate economics courses in the United States (Sohn and Romal, 2015) found statistically significant and stronger performances for face-to-face instruction. Further, the study found older/mature online instruction enrollees performed better. Concerning satisfaction, a survey of students of an online statistics course found positive satisfaction with a mean of 4.00 in a five-point Likert-scale (Al-Asfour, 2012). The study demonstrated that students were satisfied with online instructions, communications, and assessments.

On the question of students' perceptions of online homework assignments, a study of an introductory finance class discovered that, in general, students preferred online homework

to traditional homework. The study further determined that students found that the homework assignments increased their understanding of the material and graduate students reported a higher level of satisfaction than did undergraduates (Smolira, 2008). Law, Sek, Ng, Goh, & Tay (2012) examined students' perceptions of the use of the Pearson's online learning platform MyMathLab as a supplementary tool in conducting assignment and assessment in a mathematics course and found that overall the students were satisfied with the use of the MyMathLab platform.

Alrushiedat and Olfman (2013) conducted a field experiment that explored the potential benefits of asynchronous online discussions for business statistics classes and found they facilitated more and better-quality participation and engagement for undergraduates.

Walstrom (2014) compared the performance and satisfaction of over 220 students enrolled in a traditional face-to-face class and over 300 students in an online class while migrating an Electronic Business Management course from a traditional face-to-face delivery to an online delivery across a six-and-a-half-year period. The comparison revealed that student performance and satisfaction remained mostly consistent across delivery methods.

Nicholson and Nicholson (2010) surveyed student and faculty perceptions of using streaming video for teaching students Microsoft Excel and Access skills in an introductory management information systems course. The results from the survey showed that the use of a multimedia component to convey course material provided benefits to students in the form of greater satisfaction with the learning process, a greater understanding of the material, as well as a reduction in the effort required to complete homework assignments. They further reported that the instructors experienced a marked reduction in visits from students who required additional exposure to previously covered material, a decrease in prep time during subsequent semesters, and seamless portability to online learning contexts.

Fuller and Bail (2011), using an action research model, described the outcomes of an interactive team-teaching model while teaching an online graduate-level disaster research and statistics course during a span of five semesters. They

reviewed instructor reflective logs and student responses to the team-teaching model and found that there was a positive benefit in developing synergy in content and pedagogies, continued instructor learning, and continuous reflection on instructional design. They further found that the immediacy of feedback and the added access and clarity of the team-teaching process resulted in students reporting a greater understanding of the research and statistical process.

Hegeman (2015) examined whether student performance in an online College Algebra course could be improved if instructor-generated video lectures were used instead of publisher-generated educational resources. The study involved a College Algebra course that used all the publisher-generated educational resources and another course in which students completed instructor-generated guided note-taking sheets while watching instructor-generated video lectures with publisher-generated learning aids available as supplemental resources. The results of this study showed that strategically placing instructor-generated content improved student performance significantly on both online and handwritten assessments. The effectiveness of the videoconferencing software Blackboard Collaborate for carrying out instruction at the college level to students attending classes synchronously at multiple locations was evaluated by Tonsmann (2014) and found to be an effective method for educating students at a distance.

A multiple regression analysis used a dataset that included over 5,000 courses taught by over 100 faculty members over a period of ten academic terms at a large, public, four-year university (Cavanaugh & Jacquemin, 2015). This study revealed a statistical difference among course formats that amounted to a negligible difference of less than 0.07 GPA points on a four-point scale. The authors further found an interaction between course type and student GPA, indicating that students with higher GPAs performed even better in online courses. Alternatively, struggling students performed worse when taking courses in an online format compared to a face-to-face format.

Pena-Sanchez (2009) examined whether the course delivery method, online or face-to-face, and gender affected academic progress. Through chi-square tests, it was found that the population proportion of successful students in a course of

Business Statistics did not depend on their gender or the delivery mode of the class.

Wiechowski and Washburn (2014) studied more than 3,000 end-of-semester course evaluations collected from 171 finance and economics courses in the 2010-2011 academic year. They reported that the online and blended courses had a stronger relationship with high course satisfaction than did face-to-face courses. Further, they stated that there was no significant relationship found among student learning outcomes and the mode of course delivery.

Peng (2015) used an ordinary least squares regression model to analyze a sample of 206 students during the period from 2008 to 2012 and found that significant predictors of student performance were age, major, degree obtained, and the number of hours a student worked but not the choice of a more readable textbook.

Calafiore and Damianov (2011) used the online tracking feature in Blackboard (Campus Edition) to retrieve the real time that each student spent in the course for the entire semester and to analyze the impact of time spent online, prior grade point average (GPA), and other demographic characteristics of students on their final grades. They found that both time and GPA were significant determinants of the final grade.

Chen, Jones, and Moreland (2010) surveyed students in online and traditional classroom sections of an intermediate-level cost accounting course on several items related to instruction and learning outcomes. Then, they compared the student examination performance in the two types of sections. They found that both learning environments generally had similar ratings. However, where there was a difference, the satisfaction level of students in the traditional classroom was higher. Furthermore, they stated that the examination performance for 14 of 18 topic areas were similar with the traditional method producing better comprehension in three of the remaining four areas.

## METHODOLOGY

The opportunities thrown open by the increasing popularity of online courses comes with difficult challenges. They include technical challenges such as mastering software platforms for content delivery, interacting with students, online content delivery, participation, assessment, learning style, time management, and motivation.

There are technical solutions for many of these challenge and publishers offer learning platforms for popular textbooks.

Quantitative courses present tough challenges when they are offered online. Mastering quantitative aspects of problem solving is critical. Publisher online platforms have modules that provide the opportunity for students to practice and master concepts before taking tests. Pearson's MyOmLab platform includes several tools that can be used for practice and learning concepts as well as assessments. They include Practice, QuizMe, Homework, Quiz, and Test.

As students work on each section of the chapters of the textbook and achieve a minimum score in a combination of assessment tools set by the instructor, the students earn a Mastery Point. In this study, three tools were used: Practice, QuizMe, and Chapter tests. Students can learn concepts and problem-solving skills by using the practice tool, which allows students to seek help from a variety of sources including reaching out to the instructor. The QuizMe tool allows students to self-test at the level of mastery achieved by using the practice tool. In this study, we set the minimum threshold of 80% in the QuizMe for students to earn the Mastery Points associated with the section. If a student failed to achieve the minimum score, she or he could go back to Practice and then retake the QuizMe until earning the Mastery point. In as much as students can seek help while using Practice and repeat QuizMe unlimited times, Mastery Points earned had half the weight of chapter tests that were similar in content, but students could not receive any help and had only two attempts with the higher of the two grades recorded.

One of the research questions we faced was whether this process of earning Mastery Points with unlimited trials of Practice and QuizMe was helping student performance as measured by chapter tests. Further, we had both undergraduate and graduate classes in the pool of classes for which we gathered data (further described in the next section). Therefore, we formulated the following four hypotheses:

*Hypothesis 1:*

**H0:** The Mastery Score in a given chapter does not have any effect on the test score in the corresponding chapter.

**HA:** The higher the Mastery Score in a given chapter the higher the test score will be in the corresponding chapter.

*Hypothesis 2:*

**H0:** The time spent earning Mastery Score in a given chapter does not have any effect on the test score in the corresponding chapter.

**HA:** The higher the time spent earning Mastery Score in a given chapter the higher the test score earned in the corresponding chapter.

*Hypothesis 3:*

**H0:** The average chapter test scores for graduate students are the same as the corresponding average for undergraduate students.

**HA:** The average chapter test scores for graduate students are higher than the corresponding average for undergraduate students.

*Hypothesis 4:*

**H0:** There is no interaction effect between course level and Mastery Score earned on the average chapter test scores.

**HA:** There is an interaction effect between course level and Mastery Score earned on the average chapter test scores.

**THE DATA**

We chose Operations Management at the undergraduate level and Production and Operations Management at the graduate level. While there were significant differences in the range and coverage of topics between the undergraduate and graduate classes, we identified nine core chapters that were common to both levels of classes. They are given in Table 1.

Table 1. Chapters Common to OM and POM

Chapter	Description	Mastery Points
1	Productivity	10
2	Project Management	10
3	Forecasting	7
4	Managing Quality	6
5	Statistical Process Control	3
6	Inventory Management	7
7	Aggregate Planning	7
8	Materials Requirement Planning	8
9	Scheduling	7

Our study included 174 students over a period of four semesters. For each of the 174 students, data were collected on five variables for each of the nine chapters listed in Table 1. These variables are shown in Table 2. Note the Mastery Score recorded was the percentage of total mastery points available for the given chapter. Similarly, the test scores were converted to a 100-point scale for consistency.

Table 2. Variables for the Nine Chapters

Variable	Description	Variable
Course level	Graduate or Undergraduate	Course level
Chapter	Assessment chapter	Chapter
Mastery Score	Percentage of subsections of the chapter mastered	Mastery Score
Mastery Time	Time spent mastering the chapter	Mastery Time
Test Score	Test score (0-100)	Test Score
Variable	Description	Variable
Course level	Graduate or Undergraduate	Course level
Chapter	Assessment chapter	Chapter
Mastery Score	Percentage of subsections of the chapter mastered	Mastery Score

**THE RESULTS**

The summary of results is presented in Table 3. Figure 1 shows a scatter plot of average chapter Mastery Score of individual students against their respective average test score. The graduate student scores are plotted with ● and the undergraduate student scores are plotted with \*. The scatter plot shows a positive relationship between the level of mastery achieved and test score. Further, there is a clear separation of average scores between the graduate and undergraduate students.

Table 3. Average Mastery and Test Scores

Chapter	Graduate Mastery Score	Undergraduate Test Score
Productivity	98.46	94.44
Project Management	96.27	90.80
Forecasting	91.89	93.13
Managing Quality	98.83	93.64
Statistical Process Control	85.45	87.42
Inventory Management	90.56	81.49
Aggregate Planning	92.98	92.87
Materials Requirement Planning	94.08	87.17

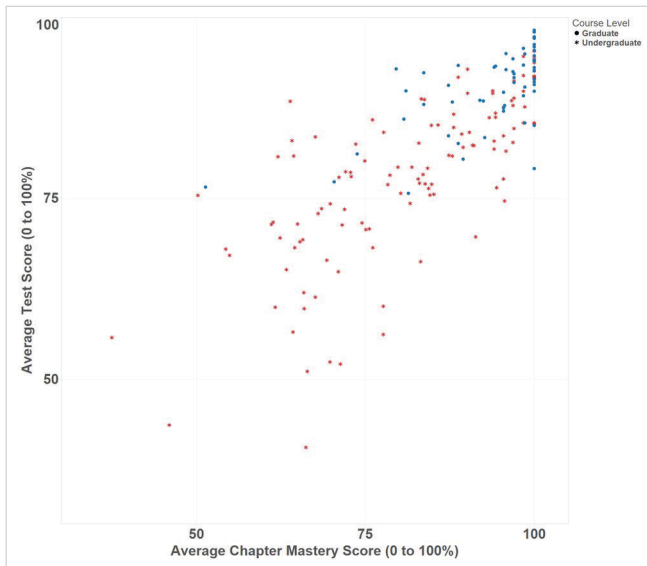


Figure 1. Average scores of individual students

Figure 2 shows the chapterwise average of all the student's scores as a scatter plot. The positive relationship between the level of mastery achieved and the test score as well as the separation between graduate and undergraduate students is evident in this plot as well.

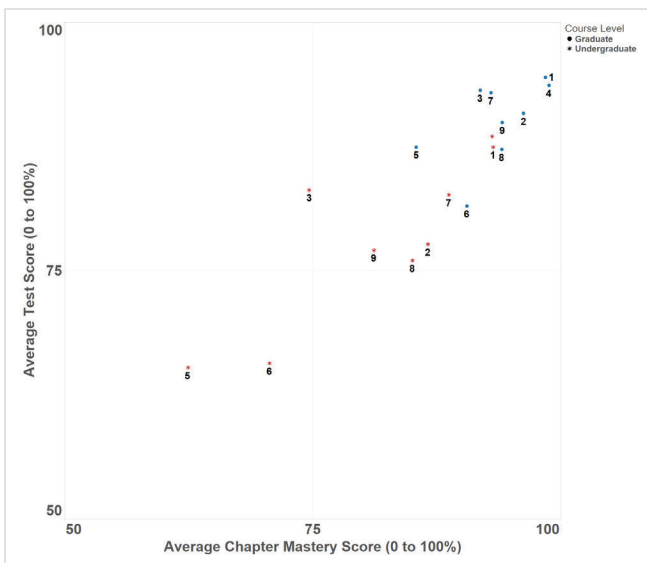


Figure 2. Chapterwise average score

Finally, we ran a regression with individual chapterwise test scores as the dependent variable and Course level, Mastery Score, and Mastery Time as the three independent variables. The overall regression results are shown in Table 4, and the results of individual and interaction effects are shown in Table 5.

Table 4. Results of Overall Regression

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	129783	32446	174.81	<.0001
Error	1427	264854	185.60		
Corrected Total	1431	394637			

Table 5. Results of Individual and Interaction Effects

Variable					
Variable	DF	Sum of Squares	Mean Square	F Value	Pr > F
Intercept	1	42.8999	1.75552	24.44	<.0001
Mastery Score	1	0.4456	0.02043	21.33	<.0001
Time spent earning Mastery Score	1	0.0021	0.00236	0.90	0.3687
Course level (Graduate)	1	25.8375	4.39389	5.88	<.0001

The results in Table 4 show that the regression between the chapter test scores as the dependent variable and the three main effect variables and one interaction effect variable as predictor is significant. Table 5 shows some interesting results and based on these results, three of the four hypotheses stated earlier were rejected and one was not rejected. These hypothesis test conclusions are discussed below.

*Hypothesis 1:* Since the p-value for the main effect Mastery Score earned was less than 0.0001, the null hypothesis was rejected, and we concluded the Mastery Score earned was a significant predictor of chapter test scores earned. The estimated regression coefficient of 0.4456 indicated an estimated increase of almost  $\frac{1}{2}$  point for the chapter test score earned for every additional Mastery Score earned.

*Hypothesis 2:* Since the p-value for the main effect time spent earning the Mastery Scores was 0.3687, the null hypothesis was not rejected. Therefore, we concluded there was no evidence found in the data that the time spent earning the Mastery Scores was a significant factor in predicting the earned chapter test score.

*Hypothesis 3:* Since the p-value for the main effect Course Level was less than 0.0001, the null hypothesis was rejected, and we concluded that the course level was a significant predictor of the earned chapter test score. The estimated regression coefficient of 25.8375 indicated that the graduate students on average were expected

to score a whopping 25 points more than the undergraduate students.

*Hypothesis 4:* Since the p-value for the interaction effect between Course Level Interaction and Mastery Score earned was less than 0.0001, the null hypothesis was rejected; and we concluded the interaction between the course level and Mastery Score earned was a significant predictor of chapter test score earned. The estimated regression coefficient value of -0.2092 revealed, interestingly, that the undergraduate students benefited more from earning more Mastery Scores than the graduate students.

## DISCUSSION

The result of the first hypothesis was expected. The process of earning Mastery Score resulted in students spending more time with practice questions and, as a result, the students achieved a better understanding of concepts tested in the chapter tests, and, therefore, scored higher. This result reveals a potential predictor of performance in addition to GPA, as found by Dotterweich and Rochelle (2012).

The result of the second hypothesis, namely the time spent earning the Mastery Scores, was not significant and may seem counter intuitive. However, the time recorded by the MyOMLab system is the duration of time the students were connected to the online tool, which may not be the same as the time actually spent working on earning Mastery Scores. It may have included idle time when students took a break or failed to log off after completing the task. Therefore, it was very likely that the time recorded by the system was not the accurate measure of time students actually spent working on earning the Mastery Scores, and this inaccuracy may have contributed to the conclusion that it was not a significant factor in estimating chapter test score earned. In any case, even if the length of time spent was not a significant factor in determining the chapter test score earned, the conclusion of Hypothesis 1 showed that earning Mastery Score was a significant factor.

While the conclusion of Hypothesis 3, which showed that graduate students scored higher on chapter tests than undergraduate students, was not surprising, the magnitude of the difference was. The level of commitment and dedication of a graduate student were likely reasons for this.

Another possible reason for this disparity was that the online format for quantitative courses were more suitable for graduate students than undergraduate students. This needs further research to confirm.

The conclusion of Hypothesis 4 revealed an intriguing insight. The regression slope coefficient for the interaction term between course level (1 = Graduate, 0 = Undergraduate) and Mastery Score earned showed that the higher the Mastery Score the undergraduates had, the higher their test scores were relative to the graduate students (all other factors held constant). If one of the reasons we speculated for the conclusion of Hypothesis 3, namely, that quantitative courses in online format were less suitable for undergraduate students than graduate students was true, then one possible mitigation strategy was to encourage students to earn more Mastery Scores. This may be achieved by setting a higher standard for earning the Mastery Score than the 80% we used or by using higher weightage for Mastery Scores in the final grade.

## CONCLUSION

Over the last decade, online course delivery has seen a remarkable growth. Studies show that the demand for online offerings will continue to grow. While the flexibility they offer is very attractive to students, instructors are hesitant to embrace them fully. One of the factors for this hesitancy is the uncertainty with respect to which strategies and tools instructors can use that will benefit students and help them to succeed in mastering course objectives. This study demonstrated the practicality of tools such as Practice and Quiz Me of the Pearson MyLab platform. In addition, such publisher-developed online tools can help bridge the gap in performance between online and face-to-face undergraduate economics courses in the United States that Sohn and Romal (2015) found. We found that the time spent earning the Mastery Scores was not a significant factor for students to improve their chapter test scores; however, it was very likely that MyOmLab overstated the time spent by students earning the Mastery Scores. The time reported by MyOmLab was the duration of time a student was connected to the system, which may have been longer than the actual time spent working because students may take breaks or, in some instances, students may not terminate the session after completing their work. Therefore,

we cannot be certain that time spent was not a significant factor. Finally, in this study, the students were not required to earn the Mastery Score before attempting the corresponding chapter test, though most students do. Whether requiring students to earn the Mastery Score before attempting the corresponding chapter test will have a significant effect on student performance in chapter tests is a topic for future research.



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