

## Assessment of a Digital Teaching and Learning Environment

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### Abstract

A digital teaching and learning environment was implemented in an undergraduate engineering course. McGraw-Hill Connect®, the digital teaching and learning environment in question, was used to replace traditional homework assignments worked by hand and submitted in class with digital homework assignments. Student performance, in the form of homework, quiz, and exam grades, was used to evaluate the effectiveness of McGraw-Hill Connect®. When compared with students in a separate section who submitted homework assignments worked by hand, students who utilized Connect® increased their average homework, quiz, and exam grades by 10.1%, 3.7%, and 14.9% respectively. In addition, 100% of the students were satisfied with their use of Connect Plus® and would use it again in future courses. Additionally, McGraw-Hill Connect® reduced grading time as assignments are automatically graded, reduced the number of office hour visits as related to homework assignments, and provided item analysis and at-risk reports which allowed for early intervention for struggling students.

### Keywords

Digital Teaching and Learning Environment, Online Learning Environment, McGraw-Hill Connect®

### Introduction

Digital teaching and learning environments are often used to supplement classroom lectures and provide students with personalized online homework assignments. M. Liberatore<sup>1</sup> utilized an online homework system, Sapling Learning®, in a material and energy balances course and found 91% of students using the personalized online homework system received a “C” or better in the course as compared with 72% of students who did not utilize the online system. J. F. Eichler and J. Peeples<sup>2</sup> utilized two online homework systems, MasteringChemistry® and Assessment and Learning in Knowledge Spaces® (ALEKS®), in a general chemistry course and found students who completed online homework activities performed significantly better on a common comprehensive final exam when compared with students who did not participate. R. A. Wahab and S. A. Baharna<sup>3</sup> employed MasteringChemistry® in a biochemistry course and similarly found the use of the online homework system resulted in a significant increase in the number of students who received an “A” in the course. In addition, 80% of the students rated MasteringChemistry® as “useful” or “very useful.” Cheng et al.<sup>4</sup> used an online homework system in an introductory physics course and found that the use of the system increased student understanding of physics concepts. R. Zerr<sup>5</sup> performed a quantitative and qualitative analysis of the effectiveness of online homework in an introductory calculus course and concluded the use of an online homework system resulted in an improvement in overall student performance. R. Zerr also found that the online system supported student engagement outside of the classroom by replicating the attempt-feedback-reattempt sequence of events that often occurs when a student

seeks help on homework from an instructor in person during office hours. D. Pundak et al.<sup>6</sup> examined student attitudes towards online homework systems and found 39% of students preferred to submit their homework assignments in a traditional hardcopy form, while 37% preferred to submit homework assignments online. In this paper, McGraw-Hill Connect® was utilized as an online teaching and learning environment in an undergraduate heat transfer course. A quantitative analysis of student performance will be performed. In addition, student opinion on the use of the online system will also be presented.

### Student Population

McGraw-Hill Connect® was utilized in an undergraduate heat transfer course as a method for students to complete homework assignments. Two sections, during the same semester and with the same instructor, of undergraduate heat transfer were studied. Section A submitted homework assignments worked by hand while section B completed homework assignments online via McGraw-Hill Connect. The students in each section were assigned four problems per chapter and solved identical problem sets. A statistical analysis was performed to verify if the two sections consisted of students with similar GPAs and course loads. A two-sample t-test assuming unequal variances was performed and can be seen in Tables 1 and 2.

**Table 1. t-Test: Two-Sample Assuming Unequal Variances**

	<i>Section B</i>	<i>Section A</i>
Mean GPA	2.85	2.95
Variance	0.23	0.33
Observations	45	23
Hypothesized Mean Difference	0	
df	38	
t Stat	-0.73	
P(T<=t) two-tail	0.47	
t Critical two-tail	2.02	

**Table 2. t-Test: Two-Sample Assuming Unequal Variances**

	<i>Section B</i>	<i>Section A</i>
Mean Course Load	14.38	14.39
Variance	4.47	2.98
Observations	45	23
Hypothesized Mean Difference	0	
df	53	
t Stat	-0.03	
P(T<=t) two-tail	0.98	
t Critical two-tail	2.01	

When comparing the average GPA of the two sections the null hypothesis (equal GPA) could not be rejected. Similarly, when comparing the average course load of the two sections the null hypothesis (equal course load) could not be rejected. The average GPA and course load in section A was 2.95 and 14.39 credit hours respectively. The average GPA and course load in section B was 2.85 and 14.38 credit hours respectively.

**Student Performance**

In order to assess the effectiveness of McGraw-Hill Connect® the homework, quiz, and exam grades of students who utilized the online homework system were compared to students who submitted homework assignments by hand. Students submitted four homework problems each chapter and completed identical problem sets. The students in section A, who turned in homework assignments by hand, could work with their peers and/or receive help from the instructor in person during office hours. The students in section B, who utilized McGraw-Hill Connect®, could re-attempt each online homework problem a maximum of three times. In addition, students could use a guided solution to step them through the problem. If a student used the guided solution they would have to repeat the problem with different numbers to receive credit for the problem.

Students who utilized the online homework system had an average homework grade 10.12% higher than students who turned in homework assignments by hand. The results were statistically insignificant however due to the small sample size in section A (23) as well as the fairly large variance for each section. A two-sample t-test assuming unequal variances was performed and can be seen in Table 3. The null hypothesis (higher homework average in section B) could not be rejected.

**Table 3. t-Test: Two-Sample Assuming Unequal Variances**

	<i>Section B</i>	<i>Section A</i>
Mean Homework Grade (Out of 10)	8.36	7.59
Variance	3.63	2.66
Observations	45	23
Hypothesized Mean Difference	0	
df	51	
t Stat	1.73	
P(T<=t) one-tail	0.04	
t Critical one-tail	1.68	

Students who utilized the online homework system had an average quiz grade 3.67% higher than students who turned in homework assignments by hand. Similarly, the results were statistically insignificant. A two-sample t-test assuming unequal variances was performed and can be seen in Table 4. The null hypothesis (higher average quiz grade in section B) could not be rejected.

**Table 4. t-Test: Two-Sample Assuming Unequal Variances**

	<i>Section B</i>	<i>Section A</i>
Mean Quiz Grade (Out of 10)	7.16	6.90
Variance	3.38	2.91
Observations	45	23
Hypothesized Mean Difference	0	
df	47	
t Stat	0.56	
P(T<=t) one-tail	0.29	
t Critical one-tail	1.68	

Students who utilized the online homework system had an average exam grade 14.87% higher than students who turned in homework assignments by hand. Unfortunately, once again the results were statistically insignificant. A two-sample t-test assuming unequal variances was performed and can be seen in Table 5. The null hypothesis (higher average exam grade in section B) could not be rejected.

**Table 5. t-Test: Two-Sample Assuming Unequal Variances**

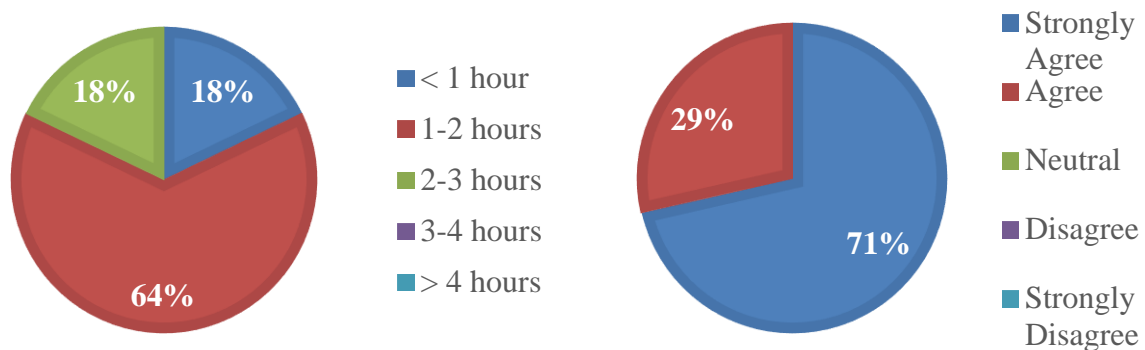
	<i>Section B</i>	<i>Section A</i>
Mean Exam Grade (Out of 10)	7.84	6.83
Variance	4.88	7.15
Observations	44	23
Hypothesized Mean Difference	0	
df	38	
t Stat	1.56	
P(T<=t) one-tail	0.06	
t Critical one-tail	1.69	

While students who utilized the online homework system, McGraw-Hill Connect®, had higher average homework, quiz, and exam grades when compared with students who did not complete homework online the results were statistically insignificant due to the small sample size in section A. Further data collection in subsequent semesters is needed to verify the results. It is hypothesized that through future data collection activities that the results may become statistically significant. In addition, it may be more beneficial to use online learning environments to reinforce conceptual content instead of purely replacing traditional homework assignments. Misconception remediation could lead to improved performance on quizzes and examinations.

### Student Opinion of Online Homework System

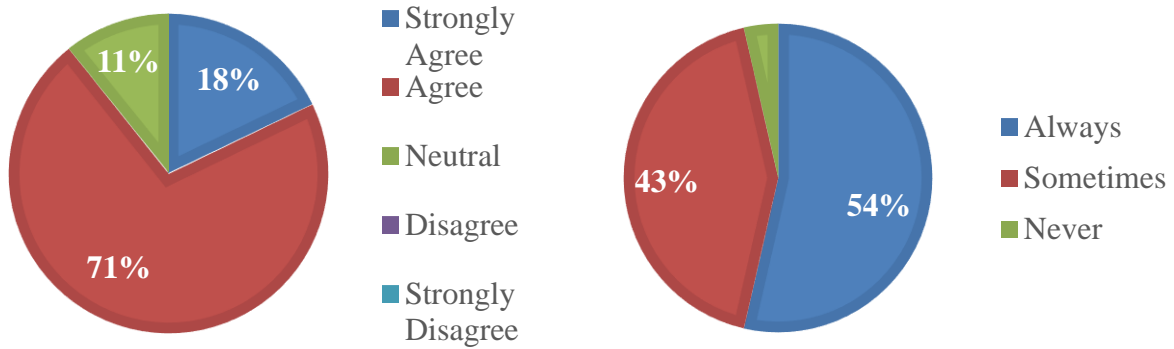
The students in section B that utilized the online homework system were polled to assess their use of the online system as well as their personal opinion on the effectiveness of the online system. Of the 45 students who were given the opportunity to complete the poll 28 participated (62.22%). Students were asked to respond to 7 different items as follows: (1) Approximately how many hours did you spend in Connect® per week? (2) I was allowed to make mistakes, learn from mistakes, and try again for better results. (3) My comprehension of this course improved as a result of Connect Plus® (4) When study attempts are enabled, students can access unlimited practice in a low-pressure environment as soon as the due date has passed. By practicing and engaging with content of instructor-designated assignments, students can better prepare for upcoming assignments and exams. Did you utilize the study attempt feature to prepare for examinations? (5) Most exercises in Connect® feature the Guided Solution which takes the student step-by-step through solving the problem much like a human tutor. Did you utilize the Guided Solution feature? (6) Were you satisfied with your use of Connect Plus® in this course? (7) Would you select Connect Plus® for your future courses?

When asked, “Approximately how many hours did you spend in Connect Plus® per week?” 64% of students responded that they spent “Between 1-2 hours” in Connect® per week (15.45% margin of error). When asked to agree or disagree with the following statement, “I was allowed to make mistakes, learn from mistakes, and try again for better results.” 71% of students “Strongly Agreed” (14.61% margin of error).



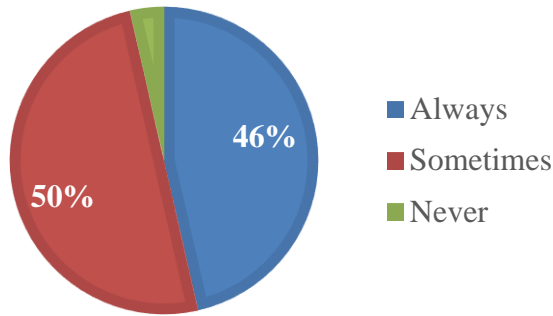
**Figure 1 (left). Time Spent in Connect Plus® per Week and Figure 2 (right). Ability to Learn from Mistakes**

When asked to agree or disagree with the following statement, “My comprehension of this course improved as a result of Connect Plus®.” 71% of students “Agreed” (14.61% margin of error). When asked, “Did you utilize the study attempt feature to prepare for examinations?” 54% of students responded “Always” (16.04% margin of error).



**Figure 3 (left). Improve in Comprehension of Course Material and Figure 4 (right). Utilization of Study Attempts**

When asked, “Did you utilized the Guided Solution feature?” 46% of students responded “Always” (16.04% margin of error).



**Figure 5. Utilization of Guided Solution**

When asked, “Were you satisfied with your use of Connect Plus® in this courses?” 100% of students responded “Yes.” Similarly, when asked, “Would you select Connect Plus® for your future courses?” 100% of students responded “Yes.”

### Conclusion

McGraw-Hill Connect® was utilized in an undergraduate heat transfer course as a digital teaching and learning environment where students could complete homework assignments. Students who utilized the online homework system had average homework, quiz, and exam grades 10.1%, 3.7%, and 14.9% respectively higher than students in a separate section during the same semester who turned in homework assignments by hand. In addition, 71% of students agreed that their course comprehension improved as a result of their use of Connect®. Finally, 100% of the students surveyed were satisfied with their use of Connect® and would use it in future courses.

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David Calamas is an Assistant Professor in the Mechanical Engineering Department at Georgia Southern University. He received a BS in Mechanical Engineering from Clemson University in 2010. He received a MS and PhD in Mechanical Engineering from The University of Alabama in 2012 and 2013 respectively. He currently teaches heat transfer and fluid mechanics. His research interests are in the in the areas of biologically-inspired heat transfer, fluid and thermal transport phenomena, active and passive thermal management as well as engineering education.