Paths to Learning: Understanding how students utilize online instructional resources in an introductory engineering graphics course

ABSTRACT

This presentation focuses on an ongoing instructional innovation research and development project centered around an introductory engineering graphics course. Over the past few years, the researchers have looked at ways that pedagogical innovations could be used to both improve instruction and do so more efficiently with fewer resources. These goals has led to the creation of pilot sections of the course that are "hybrid"—meeting one day and week and then having students use an online learning management system (i.e., Moodle) for out-of-class instruction and guidance on homework. The work presented here is an in-depth analysis of how students make use of the online resources to supplement the instructional support they receive in class. The researchers were particularly interested in answering questions concerning not only *what* resources were accessed, but *in what order*, and whether there is any statistical correlation to *learning outcomes*. In this study, the focus was on resources related to the textbook materials and quizzes and tests associated with this material. The data being analyzed was collected from 180 students taught by two different instructors over one semester. Background on the project, analysis of Moodle log file data, along with recommendations for further refinement of instructional strategies will be presented.

Keywords: hybrid instruction, blended instruction, online assessments.

INTRODUCTION

Evaluation of online learning in engineering education has pointed to the increased popularity of online course offerings in engineering fields, but has also noted the particular challenges of providing online instruction for curriculum that has a large laboratory component[1]. However, newer, web-based tools have provided flexible options for componentized delivery of engineering course resources in the media and format that best suits learning outcomes and student acceptance[2,3], including the delivery of material that was historically provided in a lab setting. The Graphic Communications faculty at North Carolina State University has been offering a blended or hybrid version of their introductory engineering graphics course since the fall 2007 semester. This format includes a two-hour face-to-face meeting each week where faculty introduce the main concepts for the unit, answer questions about solid modeling and sketching activities, and check some homework. The other portion of the course consists of online units where students can watch streaming media of textbook lectures, solid modeling demonstrations, and sketching demonstrations. The online units also include weekly quizzes on the textbook material. Previous research has shown correlation between performance on these weekly assessments and the final course grade as well as providing motivation to study the textbook material[4].

During the fall 2007 semester, the first blended sections of GC120-Foundations of Graphics were offered. Two faculty taught 3 sections of the course which included 72 students. The streaming media presentations of the textbook material, solid modeling demonstrations, and sketching demonstrations were organized on course web pages. Students could navigate through the pages in any order. Each week students also were asked to complete an online assessment or quiz in Web-CT Vista. Post-course surveys were used to get feedback from students about how they used the online materials. Students reported 19 different strategies for completing the material related to the textbook. The top 3 strategies were: 1) watched the voiced-over PowerPoint, read and reviewed the chapter(s), and then completed the online assessment (30%); 2) read and reviewed the chapter(s) and then completed the online assessment (11%); and 3) read the chapter(s), watched the voiced-over PowerPoints, and then completed the online assessment (7%). Approximately 13% of students did not use a study strategy that involved viewing the voiced-over PowerPoints[5].

This study was repeated during the fall 2008 semester with 3 sections of GC120 (74 students). The same streaming media presentations of the textbook material were available to students online. The post course survey revealed that students used 12 different strategies for studying the textbook material. The top three strategies for this semester were: 1) reviewed the textbook material and then completed the online assessment (25%); 2) watched the voiced-over PowerPoints, read/reviewed the textbook, and then took the online assessment (16%); and 3) read and reviewed the textbook and then took the online assessment (15%). In this study less than 5% of the students reported a strategy that did not involve using the textbook, however, approximately 39% of the students reported a strategy that did not involve watching the voiced-over PowerPoints. This was much higher than what students reported in the fall 2007 semester[6,7].

For the spring 2009 semester all online materials were moved to the Moodle learning management system. By placing materials within Moodle faculty could better track how students were navigating through the course. While the self-report data from students on how they used the online materials collected in our previous studies was insightful, it still suffered from students needing to accurately recall what instructional resources they used and in what order. The online logging capabilities of Moodle allows the accurate tracking of the online resources students accessed and how these patterns may have changed over the course of the semester. A similar data analysis showed that as the semester progressed, students accessed the online materials less frequently[8].

METHODOLOGY

During the fall 2009 semester, three blended learning sections of GC120 were studied. All online materials were accessed only through Moodle. An additional difference in these sections from previous semesters was the enrollment for each section was set at a maximum of 60 students instead of the 24 in previous semesters. Tables 1-3 display the demographic data of the students in the blended sections of the course.

Table 1. Enrollment Per Blended Section of GC120.

Section	Frequency	Percent
003	55	34%
004	56	34%
005	53	32%
TOTAL	164	100%

Table 2. Academic Year.

Year	Frequency	Percent
Freshmen	4	2%
Sophomore	115	70%
Junior	29	18%
Senior	16	10%
TOTAL	164	100%

Table 3. Academic Major.

Major	Frequency	Percent
Aerospace Engineering	17	10%
Civil Engineering / Construction Management	45	27%
Mechanical Engineering	44	27%
Other Engineering Majors	29	18%
Education	7	4%
First Year College	8	5%
Other Majors	14	9%
TOTAL	164	100%

There were 164 students enrolled in the three blended versions of the course. A majority of these students were sophomores (70%) since GC120 falls in the sophomore year of many engineering majors. Eighty-two percent of the students were enrolled in engineering majors with the largest percentages coming from the departments of aerospace and mechanical engineering and civil engineering.

As in previous semesters, students were required to view and complete online materials on a weekly basis. Materials were organized into 12 weekly online units. Each unit consisted of streaming media presentations of the textbook material, streaming media SolidWorks™ demonstrations, and streaming media sketching demonstrations. Students also had to complete a 10-20 question online assessment in Units 1-5 and 8-11 as a check of their textbook knowledge. They were given two attempts at each assessment, if needed. For each assessment, there was paired a streaming video of a voiced-over PowerPoint™ presentation of the key concepts of the required textbook readings for the week.

Since all of these materials were placed within Moodle, faculty could track how students progressed through the materials. Of particular interest in this study was how students made use of the online materials. More specifically, in what order did students progress through the materials related to the textbook? What was the typical number of attempts at each assessment? Did students who attempted all of the online assessments perform better on the midterm and final exams than students who only attempted a few assessments?

RESULTS

A purposeful sample of Moodle units were examined, with data for units 1, 5 and 9 used for this study. Tables 4-6 display the order in which students completed the streaming media videos and the online assessments for these three units.

Table 4. Order Students Completed Moodle Activities in Unit 1.

Order of Activities	Frequency	Percent
V	16	10%
VQ	52	32%
VQQ	63	38%
VQV	1	1%
VQVQ	7	4%
Q	7	4%
QQ	11	7%
QQV	2	1%
Did not view media or complete assessment	5	3%
TOTAL	164	100%

Q: Attempt at online assessment/quiz.
V: Viewed streaming media video of textbook material.

Table 5. Order Students Completed Moodle Activities in Unit 5.

Order of Activities	Frequency	Percent
V	4	2%
VQ	10	6%
VQQ	42	26%
VQVQ	13	8%
Q	45	28%
QQ	35	21%
QVQ	4	2%
Did not view media or complete assessment	11	7%
TOTAL	164	100%

Table 6. Order Students Completed Moodle Activities in Unit 9.

Order of Activities	Frequency	Percent
V	5	3%
VQ	12	7%
VQQ	44	27%
VQVQ	4	2%
Q	32	20%
QQ	38	23%
QQV	3	2%
QVQ	1	1%
Did not view media or complete assessment	25	15%
TOTAL	164	100%

During Unit 1 the most popular strategy for students was viewing the streaming media video and then taking the online assessment twice. As stated earlier, students were allowed a maximum of two attempts at each assessment. It follows that the second most popular strategy in Unit 1 was

viewing the video and then taking the online assessment only once, followed by only viewing the video. In Units 5 and 9, the pattern changed to one with less emphasis on the online videos. In Unit 5, viewing the video and then taking the quiz twice moved to second place with just taking the quiz either twice or once in first and third places, respectively. In Unit 9, just taking the quiz either twice or once were second and third place, respectively, with viewing the video before taking the quiz twice taking first.
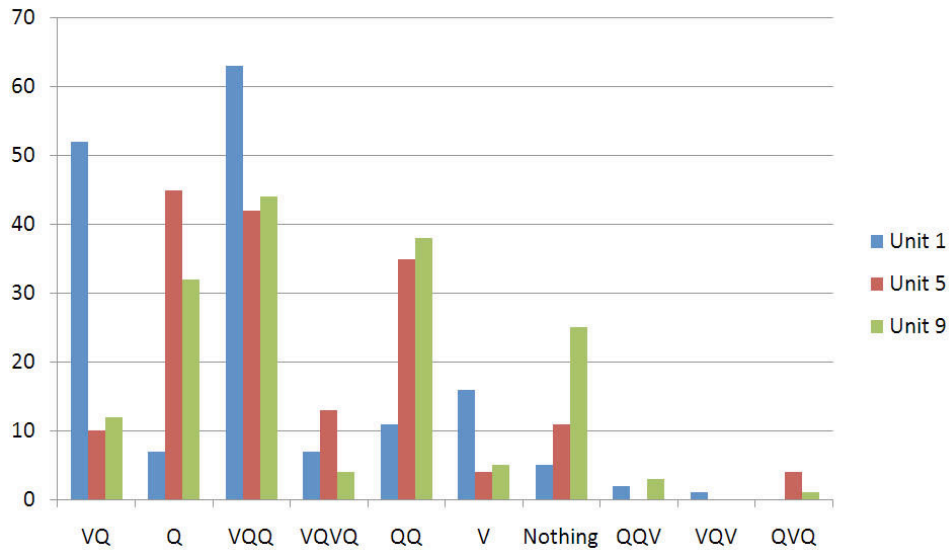

Figure 1. Moodle Activity Order in Units 1, 5 & 9.

In summary (Figure 1), the most frequently used strategy for students over the whole semester was watching the streaming media video and then taking the online assessment twice. It also appears that strategies where students do not watch any of the streaming media videos became more popular during the semester (i.e., Q, QQ, and doing nothing online). Somewhat of a concern, but perhaps in surprising, the number of students who did not make use of the any of the resources steadily increased between Units 1, 5, and 9.

Also of interest to faculty was the number of online assessment attempts students made in the units – did the number of attempts at assessments decrease, remain the same, or increase over the semester? Tables 7-9 display these data.

Table 7. Online Assessment Attempts in Unit 1.

Attempts	Frequency	Percent
No attempt at the unit online assessment	21	13%
1 attempt at the unit online assessment	61	37%
2 attempts at the unit online assessment	82	50%
TOTAL	164	100%

Table 8. Online Assessment Attempts in Unit 5.

Attempts	Frequency	Percent
No attempt at the unit online assessment	15	9%
1 attempt at the unit online assessment	55	34%
2 attempts at the unit online assessment	94	57%
TOTAL	164	100%

Table 9. Online Assessment Attempts in Unit 9.

Attempts	Frequency	Percent
No attempt at the unit online assessment	30	18%
1 attempt at the unit online assessment	45	28%
2 attempts at the unit online assessment	89	54%
TOTAL	164	100%

It appears that the number of attempts at the online assessments remained consistent over the semester with a majority of students made two attempts at the online assessments. A Friedman's test indicated that there was no significant change in the number of quiz attempts between Quizzes 1, 5, and 9 (*Chi sq* = 3.59, *p* = .166), though there seems to be a subtle shift from those making one attempt to making no attempts moving to Unit 9. Figure 2 displays these attempts over the three units.
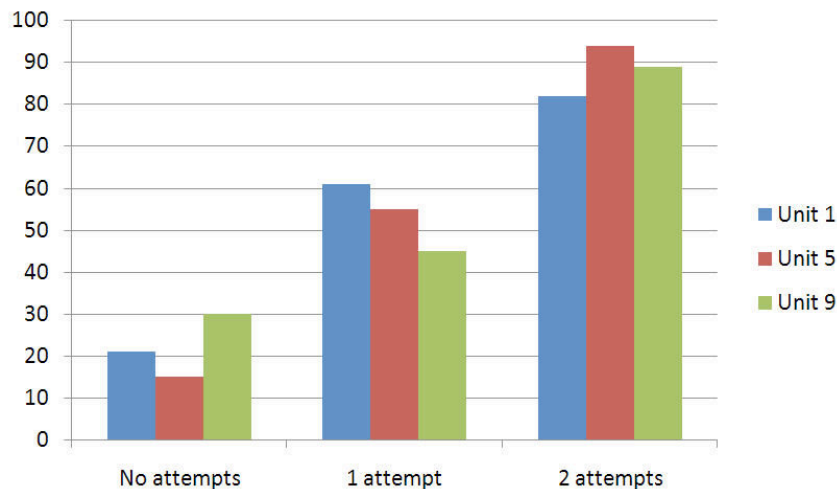

Figure 2. Number of Online Assessment Attempts Over Units 1, 5 & 9.

The final question of interest for this study was did students who attempted all or most of the online assessments perform better on the midterm and final exams than students who only attempted a few assessments? There were a total of 9 online assessments in Moodle. Five of these assessments occurred before the midterm exam. Table 10 displays the midterm exam means by the number of online assessments students attempted before the midterm exam. Figure 3 shows this data graphically. Table 11 and Figure 4 display the final exam means by the number of online assessments students attempted before the final exam.

Table 10. Midterm Exam Means by Online Assessment Attempts.

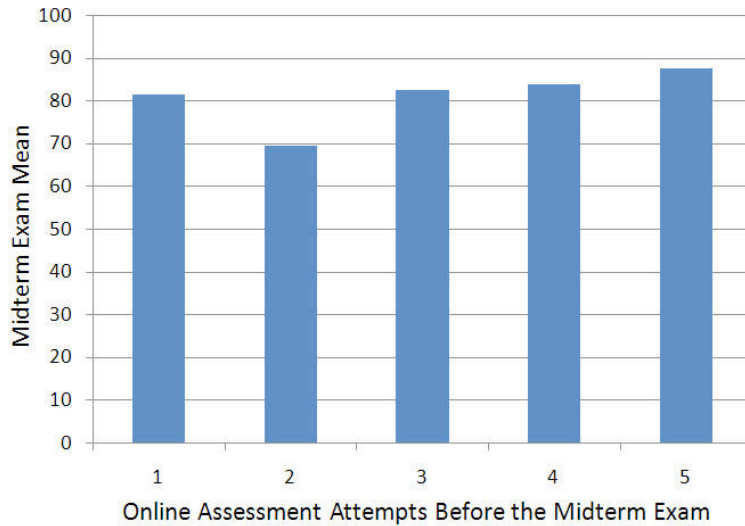| Number of Online Assessement Attempts Before the Midterm	N	Mean	SD	Min	Max
1	2	81.50	6.36	77.00	86.00
2	6	69.67	34.82	0.00	95.00
3	14	82.64	7.38	68.00	94.00
4	37	83.92	15.37	0.00	97.00
5	105	87.61	7.38	68.00	99.00
TOTAL	164				

Figure 3. Midterm Exam Means by Number of Online Assessment Attempts.

Table 11. Final Exam Means by Online Assessment Attempts.

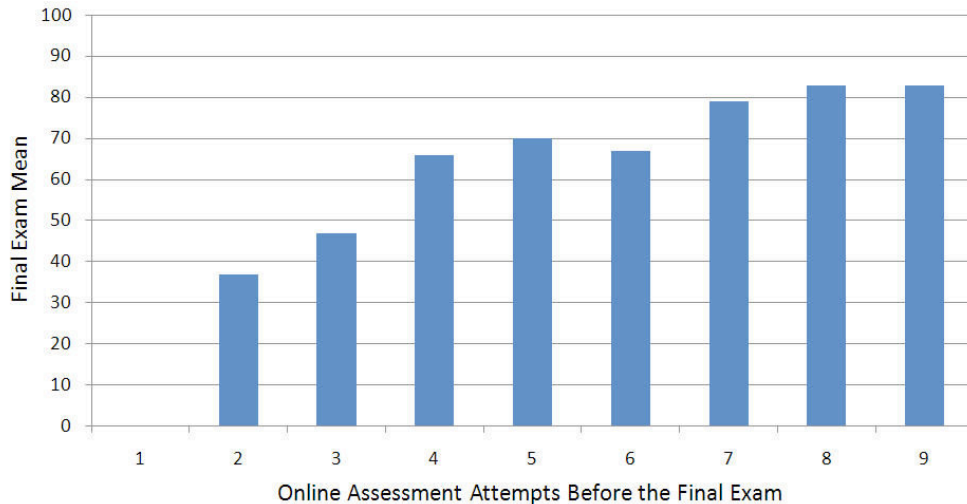| Number of Online Assessement Attempts During the Semester	N	Mean	SD	Min	Max
1	1	0.00	0.00	0.00	0.00
2	2	37.00	52.33	0.00	74.00
3	3	47.00	41.58	0.00	79.00
4	5	66.20	38.12	0.00	95.00
5	13	70.23	31.77	0.00	93.00
6	15	67.33	28.41	0.00	94.00
7	26	78.92	9.11	54.00	95.00
8	44	83.18	8.10	61.00	93.00
9	55	83.16	8.55	63.00	98.00
TOTAL	164				

Figure 4. Final Exam Means by Number of Online Assessment Attempts.

As shown in Table 10, 105 of the 164 students (64%) attempted all 5 online assessments before the midterm. To determine if a relationship existed between the number of online assessment attempts before the midterm exam and the score on the midterm exam a Spearman Rho test was conducted. The test revealed a significant positive correlation between quiz attempts and midterm exam scores ($Rho = .223$, $p < .01$). Looking over the entire semester, there were 99 students (60%) who completed 8 or 9 of the online assessments before the final exam (see Table 11). Again, using a Spearman Rho test, a significant positive correlation was found ($Rho = .283$, $p < .001$).

CONCLUSIONS

This study was a first attempt at examining how engineering graphics students study the textbook material within the Moodle learning management system. As in previous studies of our online course, students used a diversity of approaches to making use of the online resources. While a number of students followed the explicitly recommended order of material use (i.e., view the streaming video before attempting the quiz), many students took alternate approaches to usage order. In addition, while this was not tested statistically, this usage order changed over the course of the semester. Looking specifically at the number of at times students attempted the quizzes, from beginning to the end of the semester, a majority of the students made two attempts, with a few number making one attempt and even fewer making no attempts at all. This pattern did not significantly change over the course of the semester.

With the weekly online quiz assessments only worth a total of 10% of students' final grade and the midterm and final worth collectively 40% of the grade, it is our assumption that students primarily saw the value in the weekly assessments as preparing them for the larger summative assessments of the midterm and final. The data collected and analyzed supported the conclusion that those students who attempted more weekly assessments (and/or made use of the streaming videos) did better on the midterm and final exams.

Probably the most important finding of this study is that the logging tools provided in Moodle provides a powerful tool for instructors to gather and analyze data on how students make use of the resources provided online. It is now easier to chart student trends and performance in a more accurate way than in past incarnations of this course. This provides instructors with better information to use in the redesign of course materials for the future with the desire to aid the students more in learning the material. Since the production of the multimedia learning resources is a labor-intensive practice, this formative data provides valuable evidence as to whether such material is being used by students and whether it provides real educational value.

Future research work will focus on developing methods for more fine-grained analysis of log data. This work would include more data points over the semester to better understand trends, analysis of first versus second tries on quizzes, and the use of SCORM-compliant learning resources[9] in conjunction with Moodle that allow richer data collection usage (e.g., how long did they view a video and how many times did they stop and start it).

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