

Blended Instruction in an Introductory Engineering Graphics Course: Understanding How Students Utilize Online Instructional Resources

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Abstract – In a continuing effort to improve instruction, the faculty at North Carolina State University has made several major revisions to their 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. First, the course format has been changed from face-to-face to blended learning. A second revision is that this online content has been moved from open web pages with online assessments in the Blackboard learning management system (LMS) to the Moodle open source LMS. Some of the reasons for moving to Moodle include: providing a vehicle to organize course content in an efficient manner; being able to track student progress through the instructional units; providing students with feedback on their learning through online assessments; and allowing the faculty to provide consistent instruction over all sections of the course. This paper summarizes previous research conducted in the course, presents data from the 2009 fall semester, and describes technologies that have been added to the course to improve instruction.

Keywords: hybrid instruction, blended instruction, online assessments.

INTRODUCTION

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 [1].

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

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assessment (7%). Approximately 13% of students did not use a study strategy that involved viewing the voiced-over PowerPoints [2].

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 [3][4].

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 [5].

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
VQ	52	32%
Q	7	4%
VQQ	63	38%
VQVQ	7	4%
QQ	11	7%
V	16	10%
Did not view media or complete assessment	5	3%
QQV	2	1%
VQV	1	1%
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
VQ	10	6%
Q	45	28%
VQQ	42	26%
VQVQ	13	8%
QQ	35	21%
V	4	2%
Did not view media or complete assessment	11	7%
QVQ	4	2%
TOTAL	164	100%

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

Order of Activities	Frequency	Percent
VQ	12	7%
Q	32	20%
VQQ	44	27%
VQVQ	4	2%
QQ	38	23%
V	5	3%
Did not view media or complete assessment	25	15%
QQV	3	2%
QVQ	1	1%
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 (38%). As stated earlier, students were allowed a maximum of two attempts at each assessment. The second most popular strategy in Unit 1 was viewing the streaming media video and then taking the online assessment once (32%), followed by only viewing the video (10%). In Unit 5 the most common strategies for students were taking the online quiz without viewing the streaming media video (28%), viewing the streaming media video and then taking the online assessment twice (26%), and taking the assessment twice without viewing the streaming media video (21%). The top three strategies used in Unit 9 were viewing the streaming media video and then taking the online assessment twice (27%), taking the assessment twice without viewing the streaming media video (23%), and taking the assessment once without viewing the streaming media video (20%). Figure 1 displays the sum of these strategies over the three units.

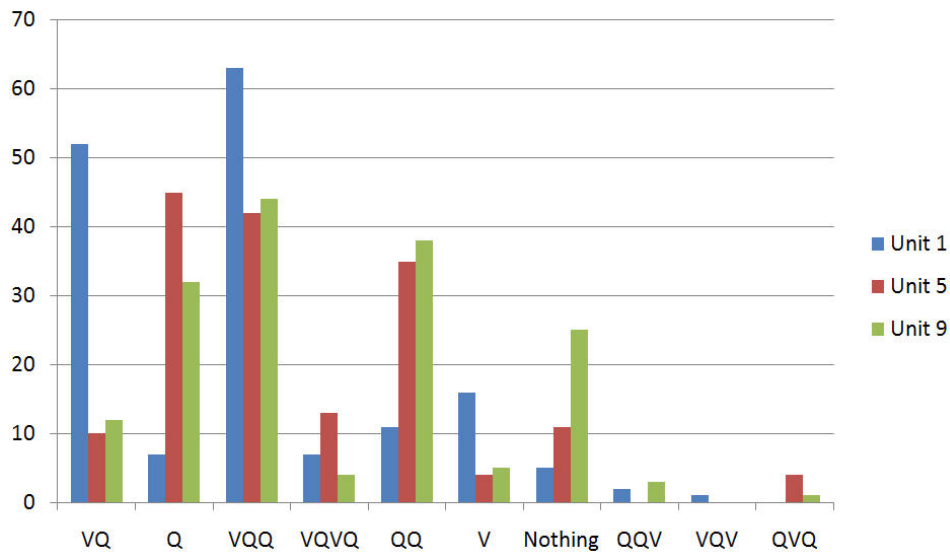


Figure 1. Moodle Activity Order in Units 1, 5 & 9.

It is clear that 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).

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 and Figure 2 display these data.

Table 7. Online Assessment Attempts in Unit 1.

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

Table 8. Online Assessment Attempts in Unit 5.

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

Table 9. Online Assessment Attempts in Unit 9.

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

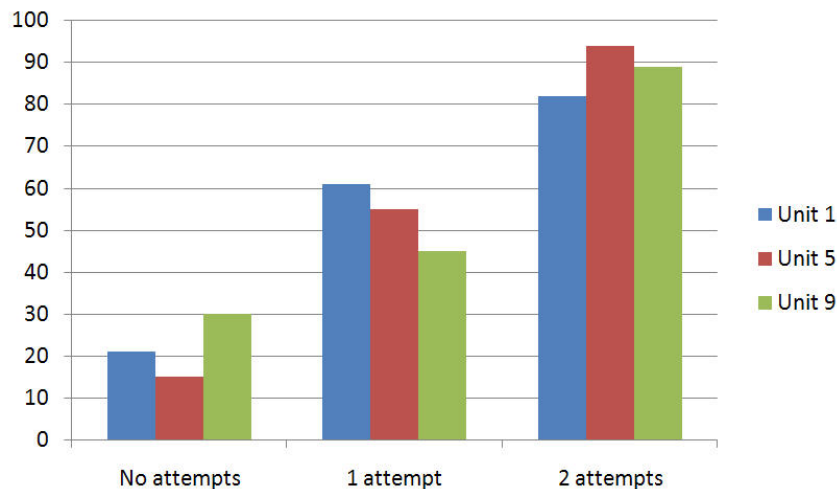


Figure 2. Number of Online Assessment Attempts Over Units 1, 5 & 9.

It appears that the number of attempts at the online assessments remained consistent over the semester. 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).

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 assessment students attempted before the final exam.

Table 10. Midterm Exam Means by Online Assessment Attempts.

Number of Online Assessment 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				

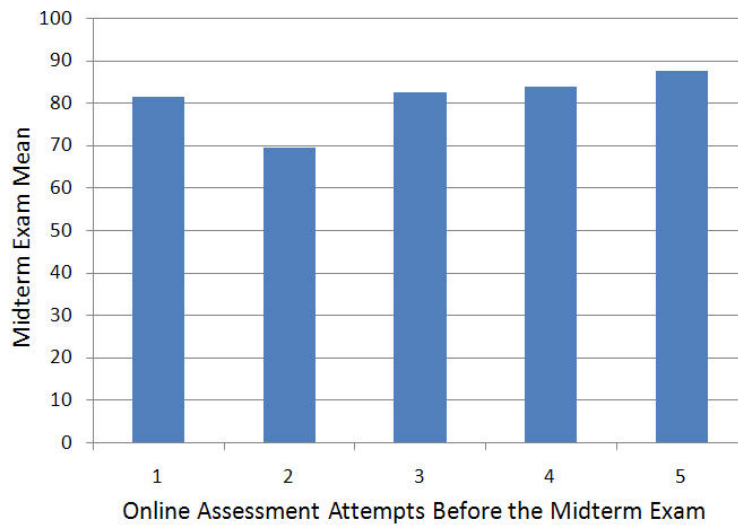


Figure 3. Midterm Exam Means by Number of Online Assessment Attempts.

Table 11. Final Exam Means by Online Assessment Attempts.

Number of Online Assessment 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				

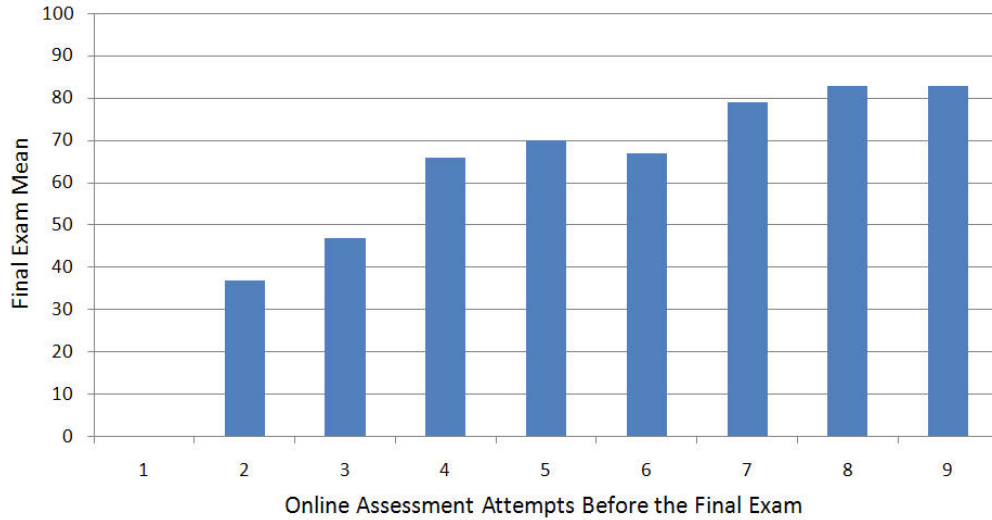


Figure 4. Final Exam Means by Number of Online Assessment Attempts.

As shown in Table 10, 105 of the 164 students (64%) attempted all 5 online assessments before the midterm. The midterm exam mean for those students appears slightly higher than those who attempted fewer assessments. There were 99 students (60%) who completed 8 or 9 of the online assessments before the final exam. Again, these students appeared to score higher on the final exam than those who attempted fewer online assessments.

Based on these trends, it was hypothesized students who attempted more of the online assessments would score higher on the midterm and final exams. 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. Table 12 displays the results of this analysis. Table 13 displays the same analysis for the assessment attempts before the final exam and the score on the final exam.

Table 12. Correlation Between Midterm Exam and Online Assessment Attempts.

Spearman's rho		Assessment Attempts Before Midterm	Midterm Exam
Assessment Attempts Before Midterm	Correlation Coefficient	1.000	
	Sig. (2-tailed)	.	
	N	164	
Midterm Exam	Correlation Coefficient	.223**	1.000
	Sig. (2-tailed)	.004	.
	N	164	164

** . Correlation is significant at the 0.01 level (2-tailed).

Table 13. Correlation Between Final Exam and Online Assessment Attempts.

Spearman's rho		Assessment Attempts Before Final Exam	Final Exam
Assessment Attempts Before Final Exam	Correlation Coefficient	1.000	
	Sig. (2-tailed)	.	
	N	164	
Final Exam	Correlation Coefficient	.283**	1.000
	Sig. (2-tailed)	.000	.
	N	164	164

** . Correlation is significant at the 0.01 level (2-tailed).

The first analysis revealed a significant correlation between online assessment attempts before the midterm exam and performance on the midterm exam ($\rho = .474$, $p < .01$). The second analysis revealed a significant correlation between online assessment attempts before the final exam and performance on the final exam ($\rho = .283$, $p < .001$).

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, this usage order also changed over the course of the semester. Less pronounced was change in the number of times students attempted the quizzes over the semester. 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. In this study one instructor recorded the average of two assessment attempts, while the other instructor recorded the highest score. It is possible that these differences might influence student performance; however, it appears that most students felt that they could improve their score on successive tries. Interestingly though, few students went back to review the video before the second quiz try.

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 seem to support 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 [6] 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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