Relationship of Final Grade and Use of On Line Course Materials for an Engineering Economics Course

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Abstract

Ranging from fully online to various hybrid formats, online learning is a significant and growing part of higher education. As online courses grow in availability, there is an increased spectrum of materials and methods used to support the student learning process. However the literature has been slow to develop in examining the effectiveness of various online tools. In particular, undergraduate engineering courses with online components have been seldom studied, perhaps due to the slow adoption of online methods in undergraduate engineering curricula.

This paper examines learning tools, how students use them, and how they relate to final course grades in an online engineering economics course. Specifically, it studies student feedback and usage patterns on tools such as instructional videos, online whiteboard sessions, online quizzes and course management system use to determine how that level of use relates to the final grade. Employing data from a well-known online learning management system coupled with a student survey, this study identifies relationships between how often students accessed various learning tools in the course management system (CMS) and how that related to the final course grade. Although correlations between use of various tools and final grade were not large, our data appears to show that students use on line learning tools flexibly to fit their learning styles. Overall use of the tools on the CMS did positively relate to final grade.

Introduction

There is no secret that online education in its many forms is a pervasive and growing trend. MOOCs (massive open online courses) have recently been in the news as schools like Harvard, M.I.T., Caltech, and the University of Texas have committed tens of millions of dollars to MOOC development with a stated goal of democratic reach.[1] In addition to enhancing wider access to information, other diverse groups see online education as potentially helping to solve a range of higher education problems. Strategically, administrators see online courses as a cost effective learning environment, especially in comparison with large lecture-style courses. Politicians on the other hand see MOOCs or online courses in general as a solution to overcrowding and a potential tool to reduce the need for new buildings and facilities. [1]

The literature is full of studies which can support a variety of pro and con views on the implications and effectiveness of online education. For example, a three-year field study of seventeen courses in an undergraduate degree in information systems, compared the process and outcomes of three modes of delivery: totally online via asynchronous learning networks, traditional face-to-face courses, and sections using a mix of traditional and online activities. It found there were no significant differences in perceived learning by students associated with mode of delivery.[2] Koenig on the other hand also studied effectiveness of various delivery

modes by conducting a survey comparing the effectiveness of three undergraduate course delivery modes: classroom, online, and video conference at a technical institute in a mid-Atlantic state.[3] A sample of 1206 students and 160 faculty completed questionnaires on effectiveness, in terms of satisfaction, for each mode. His results showed that classroom delivery was slightly more effective than technological delivery with online being slightly more effective than video conference. The same results were found for faculty satisfaction.

It is clear in reading this literature that the variables in these studies involve a variety of tools and methods employed. Coupled with variability in sampling and data gathering, the huge range of variables hinders drawing consistent conclusions. Consider for example, use of discussion boards. A recent study examined nineteen online graduate courses to find how perceived learning varies by course and its relationship to active and passive participation by students in online discussions.[4] It found significant differences existed by course and identified quality assurance as an issue in Internet-based instruction. In addition to gender differences (female students felt that they learned more than their male counterparts), it found that only active interaction, measured by the number of messages posted by students per week, was a significant predictor of perceived learning. Passive interaction, analogous to listening to but not participating in discussions and measured by the number of accesses to the discussion boards of the e-learning system each week, was not significant. Does this mean discussion boards lead to learning?

Another significant variable in these studies involves the topic or subject matter covered in the course. Domain specific studies have attempted to control this variable. In undergraduate sociology, Bergstrand and Savage examined how students evaluate online courses in comparison to more traditional face-to-face courses using data from undergraduate student evaluations of 118 courses.[5] Their results indicated that students feel they have learned less in online courses, believe they are treated with more respect in in-class courses, and rate online courses less highly than in-class courses. By contrast, they found that negative effects of teaching online are not universal for instructors, since teaching online classes actually resulted in better evaluations for teachers who typically perform poorly in the classroom. Do these conclusions mean poor teachers should be shifted to online sections and sociology topics should not be moved online?

Considering the national and academic trends, undergraduate engineering courses will increasingly come under pressure to participate in this online trend. In light of these confusing and inconsistent results in the literature, how should online engineering education be structured? The focus of our current research is to contribute to the literature on this question. Over the last several years, we have studied an area of engineering (engineering economics) to understand better how our discipline should best get involved in online learning. In a previous publication we compared two sections of engineering economics and did not identify any significant differences in learning.[6] This paper extends that work by examining what tools in the course management system students used, their perceptions of these tools and whether we could use course management system (CMS) statistics to identify a measurable relationship between use of these tools and the final grade.

The next section presents a brief overview of the literature in best teaching practices to provide context for our results. That is followed by a brief overview of how the online engineering

economics course is structured. We then present the results of our analysis, followed by conclusions.

Best Practices in Teaching

In preparation for our study and in development of our course structure, we reviewed the literature on best teaching practices. This section summarizes current perspectives on best teaching practices and issues involving undergraduate success. One of the key benchmark studies on undergraduate education was conducted by Astin who collected longitudinal data on nearly 25,000 students at over 300 institutions to assess the influences of a range of characteristics on the students' college experience.[7] Factors critical to engineering education specifically were summarized by Felder[8] in the following points:

- The quality of the college experience is strongly affected by student-faculty interactions.
- Smaller enrollments and lower student/faculty ratios both correlate with satisfaction with instructional quality, enrollment in graduate school, interest in college teaching careers, and self-reported increases in overall academic development.
- Overshadowing student- faculty interaction, student- student interaction is the single most powerful influence on growth and development in the undergraduate years.
- Many findings highlighted the benefits of cooperative learning such as students working in teams toward a common goal. Group work had positive correlations with most areas of satisfaction, including all self-ratings, and many areas of self-reported growth. Tutoring other students, which occurs in a synergistic way when teams of students work together, had positive correlations with all academic outcomes.

Another respected study of issues related to the quality of undergraduate education was conducted by Chickering and Gamson. [9, 10] This work has been summarized in seven principles often used to evaluate the university classroom experience:

1. Faculty who encourage contact with the student in and out of the classroom enhance the motivation of the student.
2. Encourage cooperative learning involving student- student interaction.
3. Active learning is more effective than passive approaches.
4. Prompt feedback is critical and shows a positive relationship to student learning.
5. Effective use of time available to maximize learning.
6. Have high expectations but standards which are attainable.
7. Employ diverse instructional methods so students can adapt to their learning style.

While the principles were originally focused on face-to-face instruction, they were structured to be practical and broadly applicable in a range of learning contexts. Based on these points, the next section describes how we structured the course to integrate with many of these best practices.

Course Structure and Research Questions

The engineering economics section studied in this paper was conducted over a traditional semester in fall 2013 and had 35 students who were at least engineering juniors. During a typical week, a chapter of the textbook was covered and students were expected to:

- Read the assigned portions of the textbook
- Download PowerPoint files and use these to view 3-4 instructional videos, each approximately 15-20 minutes long. Slide had blank parts which students completed while watching the video.
- Complete the assigned homework problems and submit to the CMS in a pdf format for grading. Graded homework was returned typically in 2-3 days through email.
- Complete a self audit quiz on the chapter and videos using the "Respondus Lock Down Browser" feature of the CMS (Blackboard). The quiz format locked down the computer and presented randomly selected questions to the students. As a learning tool, it provided correct answers for incorrect responses and also allowed one retake to assure students understood the concepts-.
- Attend one of two weekly whiteboard conference sessions which lasted approximately 45 minutes. These sessions with the instructor covered the topics completed in the previous week's chapter and previewed the coming chapter, using the Saba Meeting conferencing system. These sessions were held from 5-6PM on Monday and Wednesday and were primarily designed to answer questions and emphasize key concepts.

Table 1 summarizes how we planned for the course format to mirror best practices. The grading rubric for the course is summarized in Table 2. In addition to the standard engineering economics topics, students wrote two business memos on engineering economics problems.

Table 1: Summary of Course Structure and Best Practice Attributes

Course design attribute	**Best teaching practice**
Videos, Saba Meeting, textbook, PowerPoint slides, online chapter quizzes	Diverse instructional methods
Saba meeting sessions, quizzes, videos require blank portions of PowerPoint slides to be completed	Active learning
Saba meeting scheduled and unscheduled sessions	Faculty- student interaction
Respondus quiz and emailed homework corrections	Prompt feedback
Videos structured in short topic segments to highlight important concepts	Effective use of time

Table 2: Course Grading Rubric

Grading	**Weight**
Homework	10%
Chapter Quizzes	10%
Saba attendance	5%
Tests (2) 20% each	40%
Final exam	25%
Writing assignments • Business Memo #1 5% • Business Memo #2 5%	10%

Based on our review of the literature in best practices, coupled with feasible survey questions and information from Blackboard, we developed the following two research goals for this study:

- What did students self report as effective tools for learning in the online format?
- Could we substantiate the self report results from Blackboard course statistics?

Results are reported in the following section.

Evaluation of the Course Learning Tools

This section examines the results from the student survey and the Blackboard CMS course report system. Table 3 summarizes the student survey questions related to the question of which online learning tools did students see as effective. The responses were summarized using a 1-5 Likert scale with five being strongly agree (or the positive response) and one being the reverse or negative end.

Table 3: Summary of Course Related Questions

19. Please rate the textbook used in the course: I found the textbook was a valuable resource for this course.
Strongly Agree Agree Neutral Disagree Strongly Disagree
20. The chapter quizzes (respondus) were useful in helping me evaluate my chapter knowledge.
Strongly Agree Agree Neutral Disagree Strongly Disagree
21. The learning tools the course provided were sufficient to learn the materials (videos, respondus, homework, saba meeting, etc.).
Strongly Agree Agree Neutral Disagree Strongly Disagree
22. How often did you attend the SabaMeeting help / discussion sessions?
Always (90-100%) Frequently (70-80%) Sometimes (40-60%) Occasionally (20-30%) Never (<10%)
23. How often did you read the assigned parts of the textbook?
Always (90-100%) Frequently (70-80%) Sometimes (40-60%) Occasionally (20-30%) Never (<10%)
24. How often did you view the assigned videos?
Always (90-100%) Frequently (70-80%) Sometimes (40-60%) Occasionally (20-30%) Never (<10%)
25. The instructor was helpful in teaching the subject matter of this course.
Strongly Agree Agree Neutral Disagree Strongly Disagree

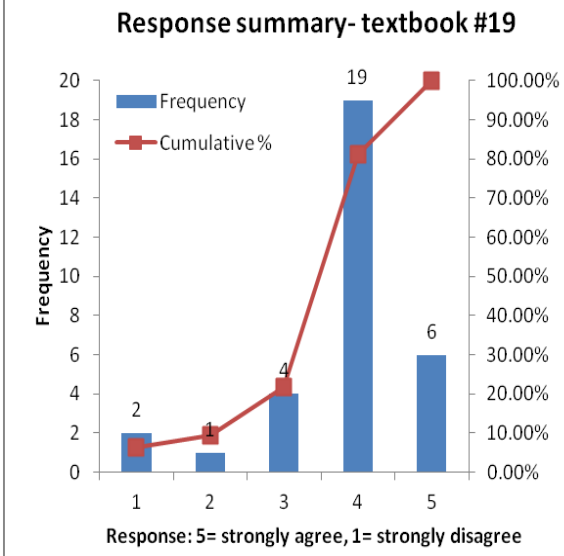
The responses to questions in Table 3 along with Blackboard data were combined to examine these learning tool areas:

- Textbook usefulness: questions 19 and 23.
- Saba Meetings: Since only 5% of the course grade was associated with these sessions, we used both the response from question 22 and the distribution of points received for attendance to evaluate student perception of the value of this tool. (Standard marketing mantra: don't draw conclusions from what I say I will do, evaluate what I do.)
- Course videos: We employed two tools to evaluate the use of the course videos. Question 24 responses provided one benchmark. The other involved data from the Blackboard site involving hits and time spent in the section containing the videos.
- Overall learning tool effectiveness: Question 21 along with general data from Blackboard on hits and time spent on the site.
- Faculty – student interaction: question 25.

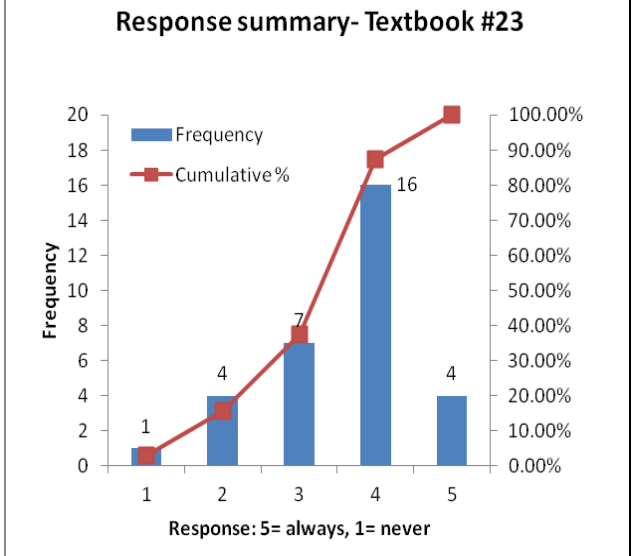
The following subsections examine the results by learning tool area.

Textbook Use Results

Per the left side of figure 1, about 80% of the students agreed or strongly agreed that the textbook was a valuable resource. However, the right side of Figure 1 shows these positive numbers went down about 20% when responding to question 23 on how often they read the assigned sections with about 60% in the frequently or always categories. We conclude that students liked the book and it was a useful learning tool. These results appear consistent with our previous course surveys.



…the textbook was a valuable resource for this course.

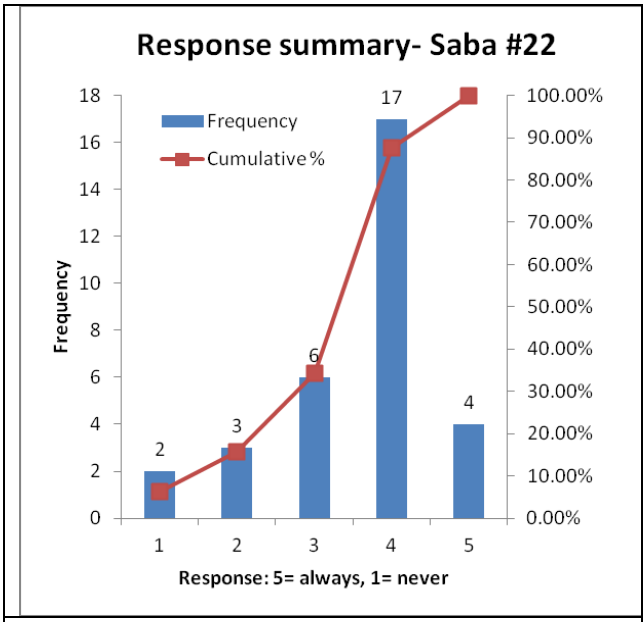


How often did you read the assigned parts of the textbook?

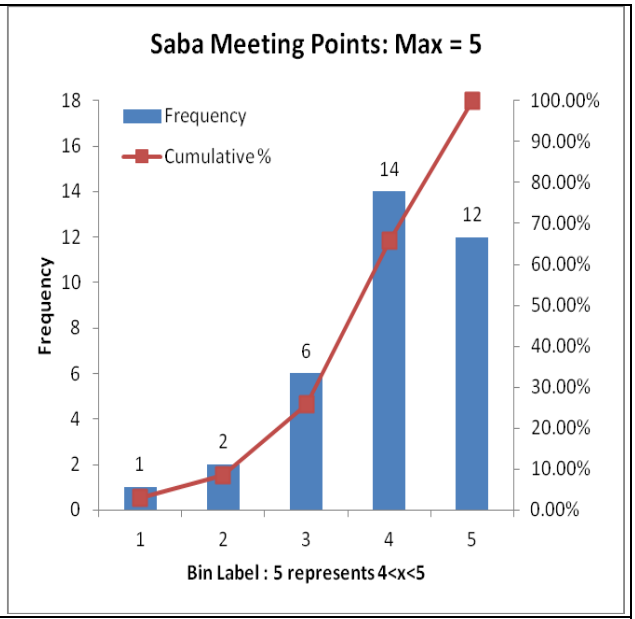
Figure 1: Textbook Response Summary

Saba Meeting Attendance Results

As noted in Table 2, since only 5% of the course grade was associated with these sessions, we used both the response from question 22 and the distribution of points received for attendance to evaluate student perception of the value of this learning tool. As shown on the left side of Table 2, 65% responded that they always or frequently attended the Saba sessions. This roughly corresponded to the grade distribution shown on the right side of Figure 2 with approximately 19 students receiving from 3.5 or more of the possible five points for attendance. Considering the importance of faculty- student interaction identified by the best teaching practices and that the Saba sessions were one of the main tools to accomplish this, these attendance and point results were disappointing.



How often did you attend the Saba Meeting help / discussion sessions?

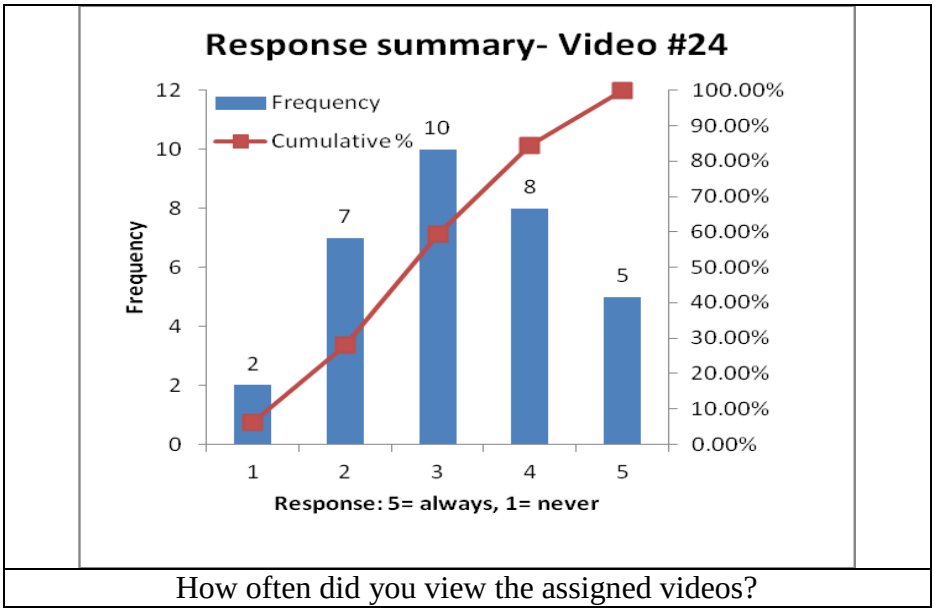


Saba attendance grade points earned out of five possible

Figure 2: Saba Meeting Attendance

Course Videos Results

Considerable effort went into providing the videos to mirror the typical class lecture. As noted in Table 1, the videos were supposed to be attractive to students to save time and to help to reverse the class room so the Saba sessions could be more problem oriented. This section examines student survey response and access information available from Blackboard. Figure 3 shows that about 40% of the students viewed the videos frequently or always with about 33 % in the seldom or never response category. This was surprising since these were supposed to provide the key information for the chapter quizzes along with reading the textbook.



How often did you view the assigned videos?

Figure 3: Video Viewing Question Summary

As a comparative benchmark for course video usage, we used Blackboard statistics to provide additional insight into the self reported data in Figure 3. Considering Blackboard is one of the most widely used CMS packages, the level of detail available from the course and student report options was very limited, primarily providing only the number and timing of hits and the amount of time the student was logged into a content area. Consequently for researchers planning to use this data, the conclusions which can be drawn are not as broad or as easily obtained as one would have hoped. Hits and time on the site can be misleading depending on site structure.

For example considering the videos and student use, one student may enter a content folder with four videos and download them quickly for later viewing while another student might stream them from the folder. In the first case, the Blackboard data would show one hit for 2-3 minutes depending on the speed of the connection. In the other case, the Blackboard data might show several hits and a 50 minute access time. If one of the students did not log-out and left the connection to Blackboard on while doing other computer tasks, the Blackboard statistics would show this "dead" time as time connected to the site.

The videos were contained in a section of the Blackboard site titled "Course Docs" and Figures 4 and 5 show the relationship between the final grade (median = 75.1) and the number of hits and the time spent in course docs. Although these figures do appear to show an increasing positive envelope in general, neither figure shows convincing evidence of usage of the videos as reflected by hits or time in Blackboard as related to final grade. The "best" result (still $R^2 = 0.1334$ only) was obtained with an exponential relationship in Figure 4, final grade and course doc hits. For the issues noted above, time spent in the course doc section was not meaningful.

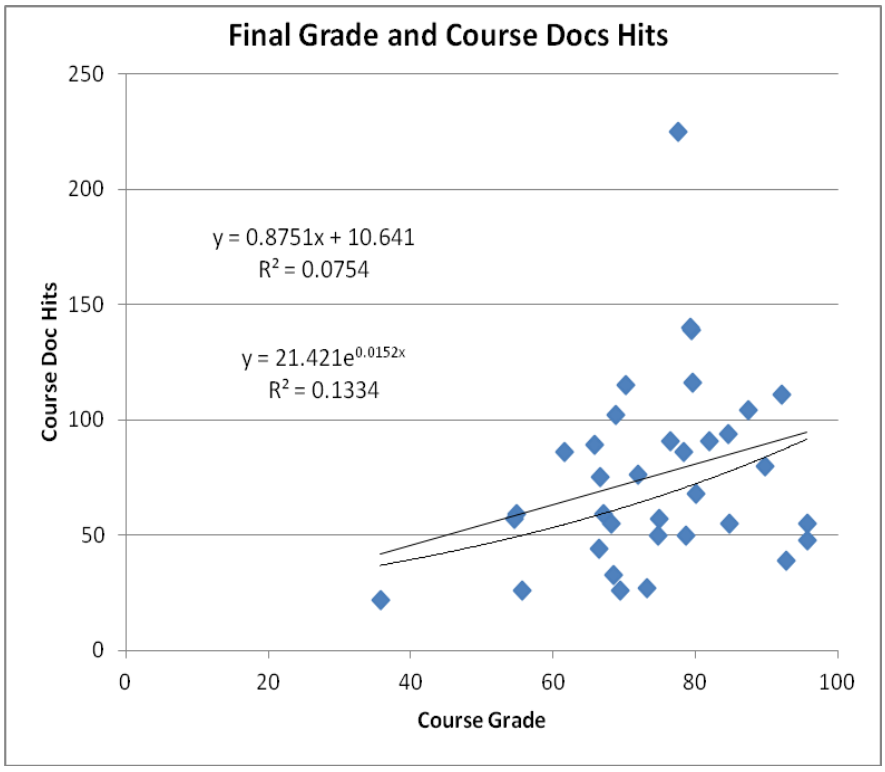


Figure 4: Final grade Versus Hits in the Course Docs Section

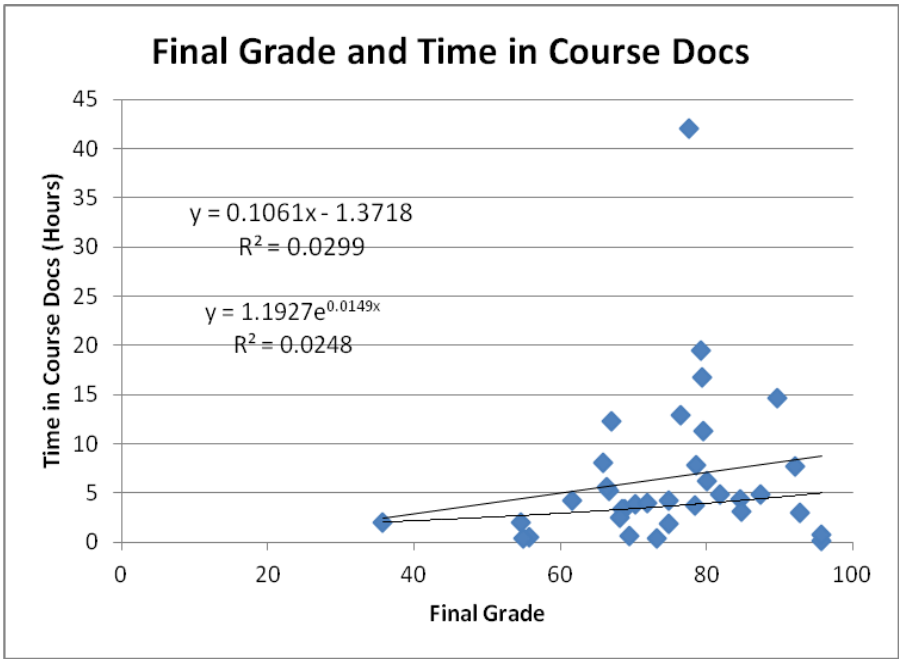


Figure 5: Final Grade and Time Spent in Course Docs

Since Figures 4 and 5 did not show clear relationships of grades and usage of videos, we manually counted the number of chapters which had been accessed by students and that result is shown in Figure 6. Once again due the inconsistencies of Blackboard and student use patterns, equation fits were not expected to be but so good. However, it was surprising that the relationship between the number of chapters with hits and the final grade was better ($R^2 = 0.182$ compared to 0.133) than Figures 4. Students who accessed more chapter folders with videos did in fact generally have better final grades.

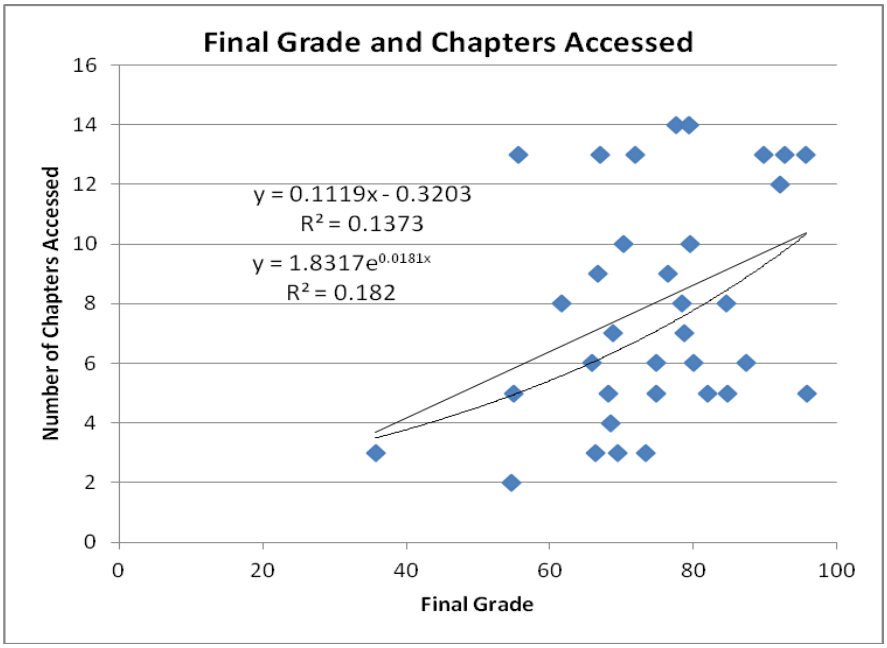
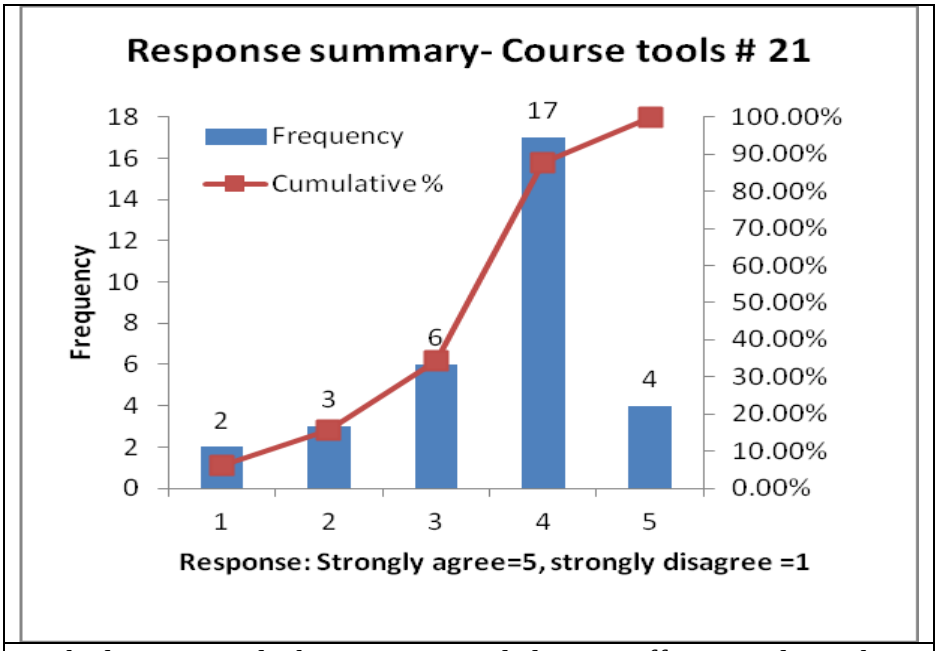


Figure 6: Final Grade and Chapters Accessed

Overall Learning Tool Effectiveness

The goal of this evaluation was to determine if the overall a set of learning tools was evaluated as useful by the students and could this be related to the final grade. This was analyzed by evaluating the self report of students on Question 21 along with examining general data from Blackboard overall site hits and total time spent on the site. Figure 7 presents the results from the student survey and shows that 65% of the students strongly agreed or agreed that the learning tools were sufficient to support learning and 15% disagreed or strongly disagreed.

To benchmark this result with Blackboard site use, we explored the relationship of overall site hits and time spent on the site with the final grade. Results are shown in Figures 8 and 9. Figure 8 relates total site time in hours to final grade and showed a positive relationship ($R^2 = 0.1717$) in figure 8 similar to Figure 6 ($R^2 = 0.182$), final grade and number of chapter s with videos accessed. Figure 9 relates final grade and the overall number of site log-ins and provided the best relationship we found ($R^2 = 0.3123$). In general, this may indicate that the level of overall use of the various tools of the Blackboard site as represented by the total hits or log-ins do contribute to the final grade.



The learning tools the course provided were sufficient to learn the materials (videos, respondus, homework, saba, etc.).

Figure 7: Sufficiency of Course Learning Tools

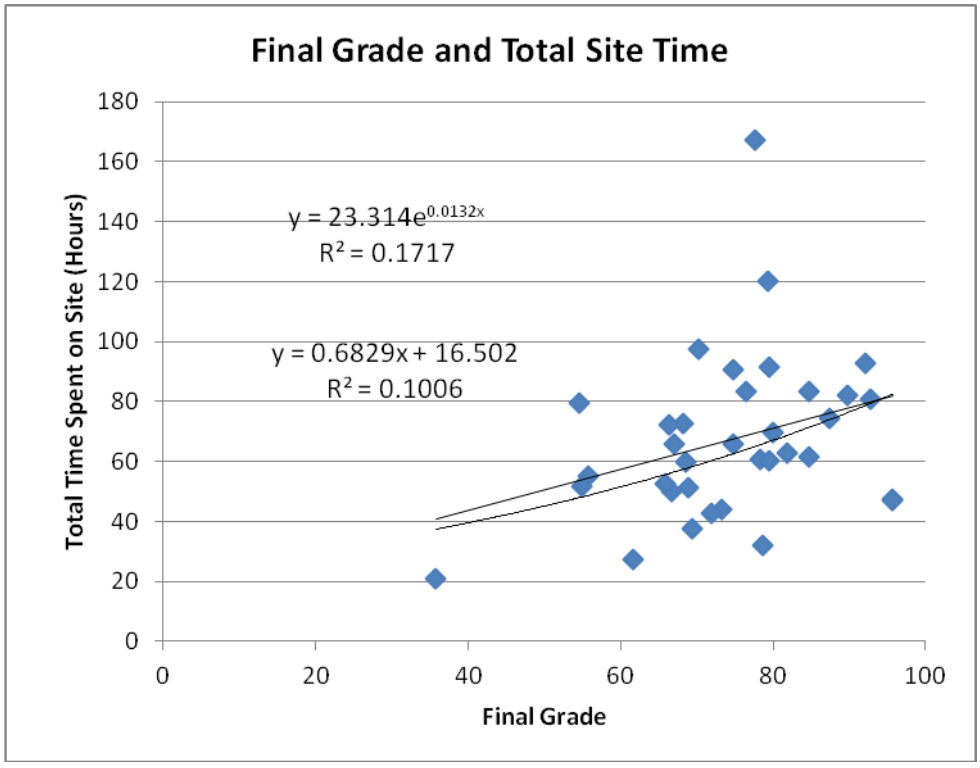


Figure 8: Final Grade and Total Time Spent in Site

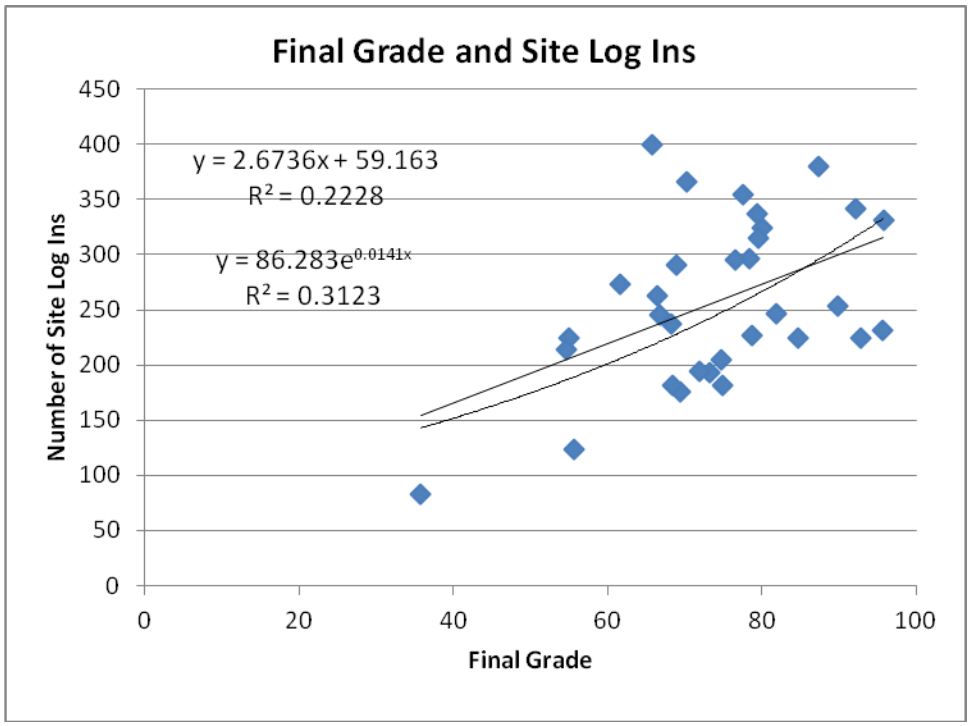


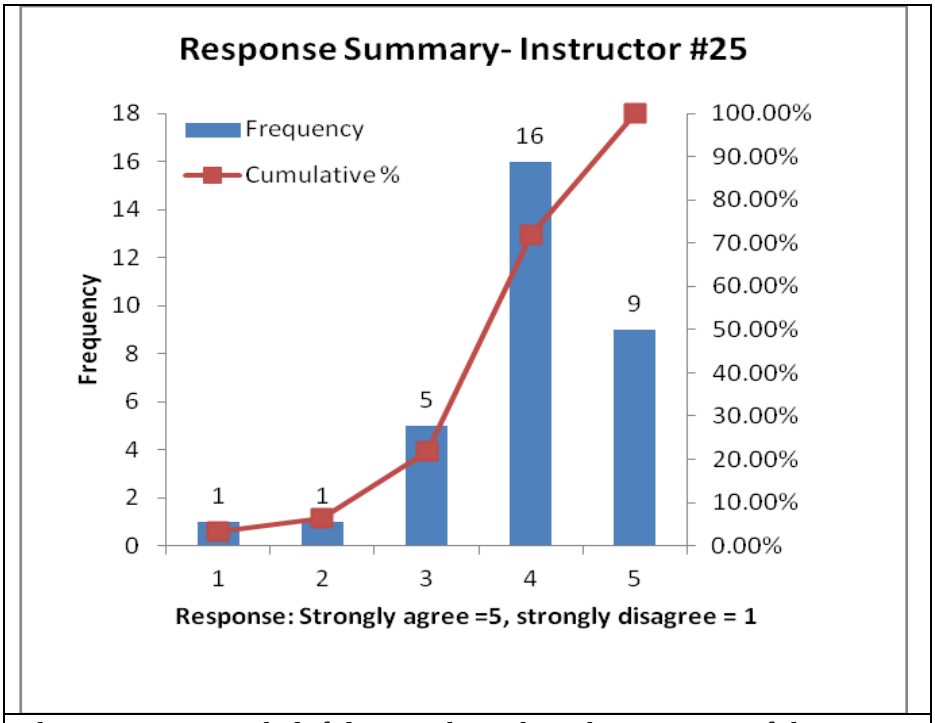
Figure 9: Final Grade and Site Log-Ins

Instructor – Student Interface

Finally, due to the importance of the instructor student relationship noted in best teaching practices, we attempted to evaluate the quality of this interface accomplished during the course. Instructor interface was accomplished in four primary ways.

- Through the weekly Saba Meeting sessions.
- By means of weekly announcements involving tasks due and work to be covered. These were generally posted and emailed over the weekend.
- By individual or group Saba meeting sessions, individually scheduled as needed outside the weekly sessions. These mirrored face to face office hours.
- Quick response to email questions

The primary tool to measure this on a broad basis was the student response to question #25 addressing the helpfulness of the instructor. Results are summarized in Figure 10 and show that only 6% disagreed or strongly disagreed that the instructor was helpful and 80% agreed or strongly agreed the instructor was helpful.



The instructor was helpful in teaching the subject matter of this course.

Figure 10: Instructor Helpfulness Summary

Conclusions

Overall results are positive that the course structure and materials provide the foundation for a positive learning experience in engineering economics. Key points are summarized below:

- Textbook: students in an online section appear to have similar use patterns to face to face sections on use of the textbook. Students appear to be more willing to be satisfied with a textbook than their usage patterns justify.
- Online meeting sessions (Saba Meeting) were attended diligently by only 65% of students. This did not appear to harm student satisfaction with the instructor interface but it does raise the question of how to make this more attractive to students without changing the grading structure.
- Course videos appear to have been viewed by a smaller percentage of students than anticipated with only 40% frequently or always viewing them. Considering that close to 100% of students took the chapter quizzes, it is puzzling students did not see these as a tool to improve quiz grades. For a subset of students, Figure 6 shows the potential benefit which may have been missed by ignoring these. This area merits additional study and possible course changes such as breaking the chapter quizzes into smaller portions based on the individual videos.
- Overall tool effectiveness appears to be accomplished. Students are a diverse group with different methods and learning styles. It appears there were sufficient options so students could find learning tools which work for them. The best evidence of this was shown in Figure 9 which indicates an $R^2 = 0.312$ between overall site hits and final grade.
- Finally, the level of satisfaction with the teacher- student relationship was positive based on the variety of interfaces employed.

Several other points are worth noting related to more general findings from our work. As we reviewed best practices compared to our course structure, we realized that student to student interaction was a key success factor we failed to identify earlier in planning the course structure. We plan to implement several changes to promote this important learning tool during the next semester. One possible idea involves student teams presenting problem solutions and integrating this activity into improving attendance at the Saba sessions.

One question which is difficult to evaluate in any course is the grade distribution and what that means. In a previous study,[6] we closely paralleled specific questions and grade results and found no significant differences in engineering economics performance between a face to face and on line hybrid section such as this one. We did not have a parallel section to compare these current results with. In addition we are not able to go back in time to past semesters since we have only taught this two credit version for two years. Consequently we are working to build our understanding of what grade distributions indicate. For reference, Figure 11 presents the grade distribution for this section. As mentioned earlier, the median grade was 75.

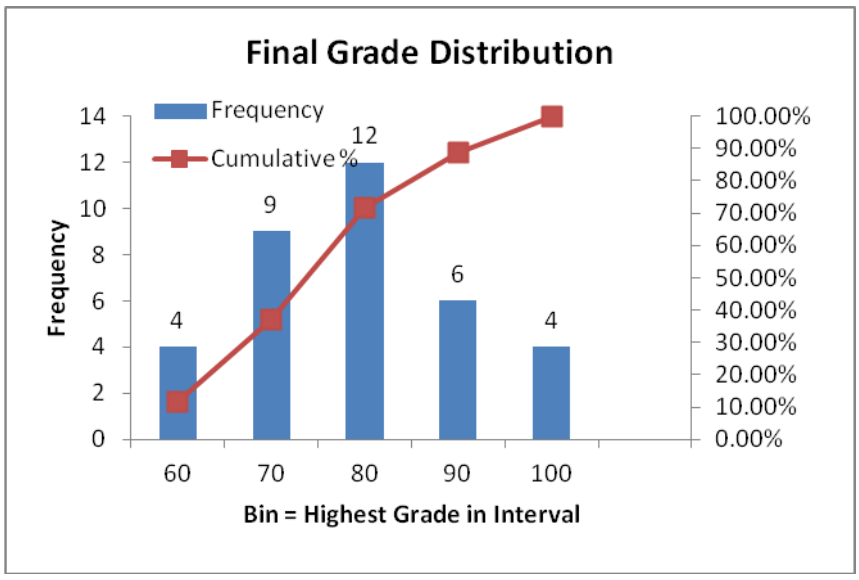


Figure 11: Course Grade Distribution

Finally we found that Blackboard course reports are a weak tool to evaluate very specific course usage details. The poor structure and capability of these reports was surprising. It is important that instructors planning online courses structure the CMS to maximize the capabilities of the course reporting system. However it is important not to confuse the students with a non logical course structure to accomplish this. We plan to explore potential revisions of the web site to take better advantage of the limited capabilities of Blackboard course reports.

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