# AC 2009-1351: THE EFFICACY OF SCREENCASTS ON DIVERSE STUDENTS IN A LARGE LECTURE COURSE

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incorporation into mineral structures, and actinide oxide solid-solutions. She is an Office of Civilian and Radioactive Waste Management Fellow, which supports her graduate research. In her four plus years as a graduate student, Shuller has been a graduate student instructor for two Materials Science and Engineering courses and assisted in two semesters of Mineralogy in Geological Sciences. In addition, for the past two years she has organized and lead a two-week high school course through the Michigan Math and Science Scholars program. This year Shuller began assisting in pedagogical research looking at the impact of screencasts on student learning.

# The Efficacy of Screencasts on Diverse Students in a Large Lecture Course

**Screencasts, Lecture Recordings, Student Usage, and Large Lecture**


## Abstract

University lecturing is changing as a result of larger class sizes, a more diverse student body, and the advent of technologies that could be used to enhance classroom instruction (i.e. Tablet PCs, personal response systems, etc.). One of the newest technological developments is screencasts, which are recordings that capture audio narration along with computer screen images. This study documents the strategic use of screencasts in an introductory Material Science and Engineering (MSE) course, and examines the impact on student learning and satisfaction in the large lecture environment. This course has an average of 200 students per semester representing all class levels and more than eight engineering majors. One teaching challenge is that the background and motivation of the students are quite diverse. Another is that the course content spans the entire range of a very multidisciplinary field. This paper analyzes the use and benefit of screencasts across the social and academic diversity of the students.

As a way to address these challenges, the instructor develops and posts several types of screencasts to the course management website to supplement the typical course resources. These types include lecture recordings; explanations of homework, quiz, and exam solutions; and explanations of topics that students identified as being unclear. To assess screencast effectiveness and design course refinements to enhance their use, we collected data for two terms on student perceptions of screencasts, their screencast usage, their course performance, and student demographics. The results from the first term were used to make revisions to the course design for the second term. The data were also used to correlate students' success in the course with their demographic and academic backgrounds. The responses from an online survey show that the vast majority of students believe these screencasts are "helpful" and used the screencasts to clarify misunderstandings, to supplement the lecture material, and to review for exams. Our initial analysis of screencast usage shows that the class is evenly divided between students whose use of the resource is low, medium, and high. Analysis showed further differences by gender, race, and student major. Analysis to date does not correlate screencast usage with performance in the course; however, more detailed analysis is underway. Results from 2007 are being compared with those from 2008 to determine the impact of course refinements on these statistics. This study suggests that the use of screencasts maybe be an effective way to supplement lecture material in large courses for all students.


## 1. Introduction

Emergent technologies are transforming higher educational practice, proliferating at a rate far faster than that of research that analyzes how they are being used, whether they are making a difference to student learning, and whether such difference is equitably distributed among students who vary in academic and social backgrounds. Lecture recordings are one of the newest technological innovations to serve teaching and learning. Will their availability empty

classrooms? Will they lead to passive learning, rather than the active strategies long known to enhance learning? [1, 2, 3, 4] Can they enhance learning?

Early analyses of lecture capturing programs showed only a modest student usage, and little impact on class attendance. A pilot program at Duke University,[5] the University of Washington-Seattle,[6] the University of Windsor,[7] and the University of Michigan[8] tracked student use based on "hits" from websites where the recorded lectures were posted. These pilots involved faculty who did not tailor their teaching in light of the fact that lectures were being recorded and posted. Analysis showed that 20%-30% of undergraduates used the resource extensively, with much higher percentages of students tapping into the resource at some point.

More recent studies show higher student use rates of lecture recordings, and begin to identify variations in student use. For all of these, students' self-reports indicate they use the posted lecture material for review, or to hear lectures when they have had to miss class because of illness, holiday, or family need. [9, 10, 11, 12] An additional study took a closer look at the variation in the extent of student use of recorded lectures, documenting a range from 43% using less than 5 recorded lectures, 38% using between 5 and 12 recorded lectures, and 19% saying they used all of the 13 recorded lectures.[13] Even with these high rates of use, all of the aforementioned studies document a minor drop in attendance.

To date, little analysis has been done on student performance based on usage of web-based resources. One study analyzed the impact on course performance of students using web-based resources, compared to those attending in-class lectures, and the comparative impact on students of varying academic background. This case demonstrated a beneficial impact of the web-based lecture materials for students with lower incoming academic ability.[14] Grabe and Christopherson have done valuable studies looking at lecture recordings as a resource for note-taking, and they have found positive correlations with exam performance.[12]

The focus of this paper is more specific than most of those cited above: the use and impact web-based *supplementary* materials. In a rare study focused on a context like ours, where mini-lectures posted on the course management system provided supplementary material, the analysis showed extensive student use – but no impact on student performance.[11]

Thus our study takes a form that builds on and extends other analyses of web-based lecture resources. Moreover, we open new ground: probing into more nuanced analysis of student use, exploring impact on student performance, and beginning to examine the impact of these resources on teaching. With increasing attention to issues of social equity, it is important to determine if gender, race, native language, or socio-economic status are factors in students' success in utilizing new technologies.

In our work, we examine different types of screencasts, which are videos that capture the activity on a computer screen with real time audio commentary.[15] Like traditional texts, they can be studied at each student's individual pace, or studied selectively. They are available "on demand" and accessible to students at any time of day (in contrast to office hours, live chats, etc.). Rather than putting students in a passive role, screencasts can enhance active study and learning.

This study investigates student use of screencasts for two semesters (Fall 2007 and Fall 2008) in a lecture course MSE220, Introduction to Materials and Manufacturing. MSE220 is a large survey course that, on average, has 200 students per semester. The student population in the course is evenly distributed between sophomores, juniors, and seniors. This course is one of two gateway courses into the Material Science and Engineering department at the University of Michigan; but the majority of the enrolled students come from several other departments (e.g., Aerospace, Chemical, and Industrial and Operations Engineering) that have designated this course as a technical elective. The prerequisite for this course is one semester of either inorganic or organic chemistry. One challenge of teaching MSE220 is that the background and motivation of the students are quite diverse. Another challenge is that the course content spans the entire range of a very multidisciplinary field. As a way to address these challenges, the professor – Millunchick– developed screencasts to supplement typical course resources such as the lecture, text, and homework materials, and she worked with co-authors (Pinder-Grover, Bierwert, and Shuller)– to research the impact on her students.

To determine the efficacy of screeencasts, we use data on student perception, usage, and performance to investigate the following research questions:

- How do students use varying kinds of screencasts?
- Which students use screencasts?
- Does student use of screencasts affect learning, in terms of self-report and/or in terms of exam performance?

## 2. Background

In this course, all lectures were captured and posted on the course management website. Figure 1 shows a screen-capture of the interface of the lecture capture system. The screen on the right shows the image projected to the class, and the screen on the left shows the instructor. The movie can be scrolled forward, backward, or paused using the controls on the screen.

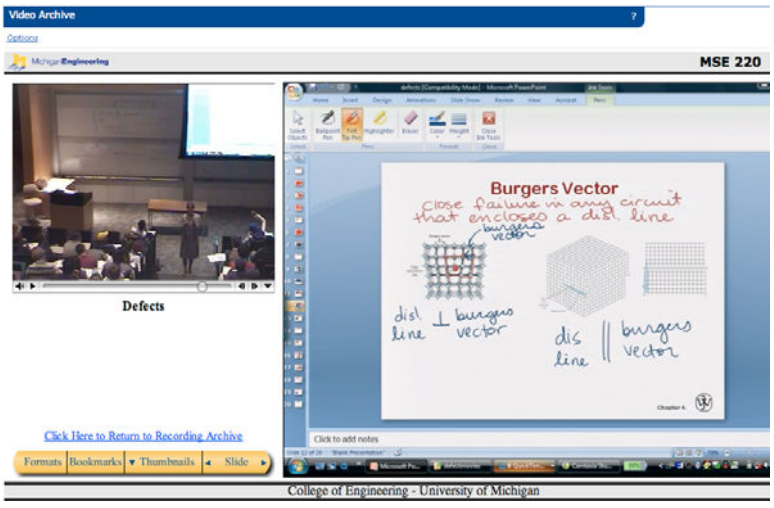



Figure 1. Screen-shot of the lecture capture system

One way the professor used screencasts was to create explanations of the homework, quiz, and exam solutions. In this case, the instructor went through detailed solutions of each of the problems. This approach is more comprehensive than simple annotated solutions, because it is possible to show the student where in the text or lecture notes the concept is described, talk through setting up the problem, and demonstrate how to use computational tools, such as Mathematica, to find the solution. Figure 2 shows a screen-shot of a homework solution screencast, which includes a Mathematica notebook solution.

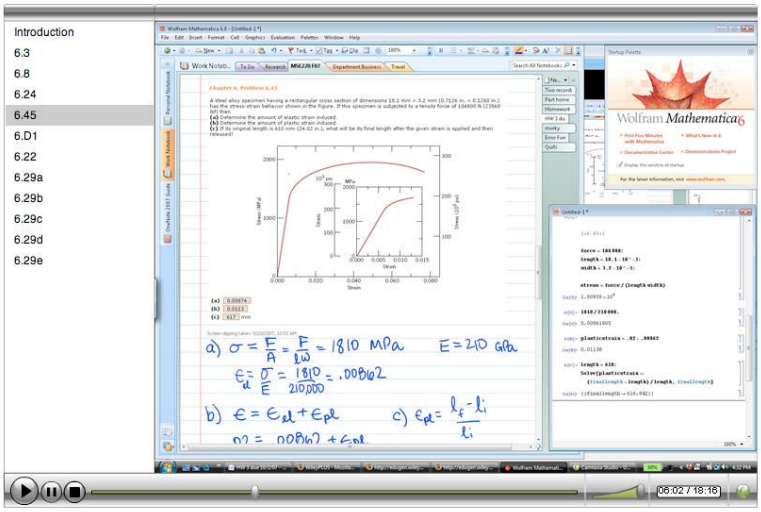



Figure 2. Screen-shot of a homework solution screencast

Another way the professor used screencasts was to address topics that students identified as unclear by using an approach inspired by a classroom assessment technique advocated in faculty development literature, "The Muddiest Point" assessment.[16] Students were asked at the end of each of the 17 units to identify the unclear concepts. In Fall 2007, students were given blank index cards to identify one or two concepts or topics that they *did not* fully understand for each chapter, and one or two concepts or topics that they *did* understand. The professor created a mini-lecture screencast based upon the responses in order to provide additional explanations, worked out problems, or examples as appropriate at the end of each chapter. For example, Figure 3 shows a screencast that is comprised of short oral reviews of the topics with schematics and flash animations to illustrate the underlying physics. No more than 15% of the students identified any one problematic topic in any chapter, but those identified were concepts that students have historically found difficult in this course (i.e. basis, true stress, error function, slip, lever rule, and polymer structures). For the most frequently named concepts, the professor created a screencast. In all, 6 mini-lecture screencasts were developed. The responses to the index card surveys varied widely, and were occasionally extraneous. Also, the response rate was less than 30%. Therefore, in Fall 2008, we altered our approach to determining which concepts were still unclear to the students. We required online questionnaires to probe for concepts that the students found unclear. These concept checks were directly aligned with the learning objectives for each unit in the course.

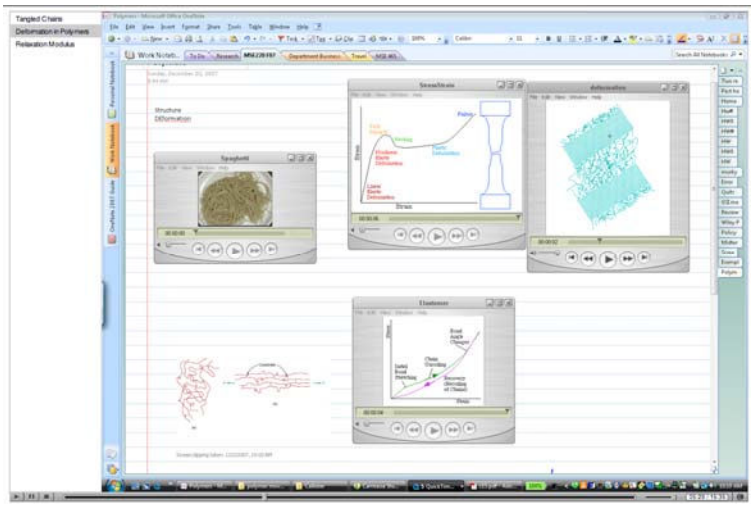


Figure 3. Screen-shot of a "muddiest point" screencast

## 3. Methodology

While midterm student feedback and end-of-term course evaluations used to assess the overall course, the authors created an end-of-term online survey to evaluate students' perceptions of screencasts. With the approval of our universities' Institutional Review Board (IRB), the designed survey asked students about the difficulty of particular concepts, how they used the screencasts, whether the resource was helpful, and whether they had any technical difficulties with the screencasts. For Fall 2008, we expanded our survey to ask students about their specific approaches to using lecture recordings, homework solution screencasts, quiz/exam solution screencasts, and "muddiest point" screencasts. Further students were asked to describe how their engagement with the lecture affected their attendance and their in-class learning.

For Fall 2007 and Fall 2008, 144 and 211 students respectively were directed to an online survey developed in SurveyMonkey via e-mail. Prior to this research project, 10 students from Fall 2007 and 8 students from Fall 2008 had previously indicated that they did not want to receive surveys from SurveyMonkey. Because of this limitation, we were unable to send an email to all students enrolled in the class to direct them to the survey for this research. The response rates for the surveys were 53% (76 out of 144) and 68% (143 out of 211) for Fall 2007 and Fall 2008 respectively. In our analysis, the quantitative analysis was primary. We report descriptive statistics and provide illustrative quotes to further illuminate key numerical findings.

In addition, the authors received student demographic data from the universities' registrar office as approved by the IRB, as well as student usage data from the college's technical support. The instructor also designed the quiz and exams questions to test whether or not specific concepts were understood by the students. We investigated the correlation between logged student use and student performance on assignments (final grade, exams, quizzes, homework).

## 4. Student Demographics

Student demographics and departmental background are highlighted in Table 1. Out of the 154 students taking the course in Fall 2007, 77% were male (N=117) and 60% were Caucasian (N=93). In the Fall 2007 analysis, students of color include Asians (17%, N=27), African

Americans (5%, N=7), and Hispanic Americans (3%, N=4). There were 23 students (15%) whose race/ethnicity was not provided, so statistical analysis based on race does not include these individuals. In Fall 2008, the gender and racial backgrounds of the 219 students taking the course were comparable to Fall 2007 in that 75% were male (N=165) and 64% were Caucasian (N=141). In Fall 2008, students of color included Asians (20%, N=39), African Americans (3%, N=6), Hispanic Americans (0.9%, N=2), and Native American (0.5%, N=1). About 14% of students did not identify their race (N=30) and are not included in the analysis focusing on race.

Student academic and class levels are highlighted in Table 1. The majority of students taking MSE220 during both terms were from Aerospace Engineering, Chemical Engineering, and Industrial and Operations Engineering. Students majoring in Material Science and Engineering comprise of a small fraction of the student population for both terms. In Fall 2007, nearly half of the students in MSE220 were juniors, a third were sophomores, and one-fifth were seniors. The distribution for Fall 2008 varied slightly such that nearly half were juniors, but slightly more than a half were divided evenly between seniors and sophomores. For both terms the average cumulative GPA (3.1), average SAT (1337), and average ACT scores (29) were comparable.

Table 1. Student Background Characteristics for Fall 2007 and Fall 2008

| | Fall 2007 | | Fall 2008 | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| **Sex** | | | | |
| Males | 117 | 76.0 | 165 | 75.3 |
| Females | 37 | 24.0 | 54 | 24.7 |
| Total | 154 | 100.0 | 219 | 100.0 |
| **Race/Ethnicity*** | | | | |
| Caucasian | 93 | 60.4 | 141 | 64.4 |
| African American | 7 | 4.5 | 6 | 2.7 |
| Asian | 27 | 17.5 | 39 | 17.8 |
| Hispanic | 4 | 2.6 | 2 | 0.9 |
| Native American | 0 | 0 | 1 | 0.5 |
| None+ | 17 | 11.0 | 30 | 13.7 |
| Not Included* | 6 | 3.9 | | |
| Total | 154 | 100.0 | 219 | 100.0 |
| **Academic Level** | | | | |
| Senior | 51 | 33.1 | 59 | 26.9 |
| Junior | 71 | 46.1 | 101 | 46.1 |
| Sophomore | 32 | 20.8 | 59 | 26.9 |
| Total | 154 | 100.0 | 219 | 100.0 |
| **Major** | | | | |
| Aero Eng | 50 | 32.5 | 60 | 27.4 |
| Chemical Eng | 34 | 22.1 | 49 | 22.4 |
| NucE & Rad | 10 | 6.5 | 19 | 8.7 |
| Ind & Op Eng | 31 | 20.1 | 53 | 24.2 |
| Mat Sci & Eng | 10 | 6.5 | 9 | 4.1 |
| Other Eng (Mech. Civil, etc) | 18 | 11.7 | 26 | 11.9 |
| Other (Non-Eng) | 1 | 0.6 | 3 | 1.4 |
| Total | 154 | 100.0 | 219 | 100.0 |
| **Cumulative GPA^** | | | | |
| Average Cumulative GPA | 3.09 | -- | 3.18 | -- |
| 4.0-3.6 | 26 | 17.0 | 48 | 21.9 |
| 3.5-3.0 | 67 | 43.8 | 93 | 42.5 |
| 2.9-2.6 | 39 | 25.5 | 46 | 21.0 |
| 2.5-2.0 | 17 | 11.1 | 24 | 11.0 |
| 1.9 and below | 4 | 2.6 | 6 | 2.7 |

+ Students who identify themselves as “none of the above”
*Missing data for 6 Fall 2007 students
^Missing data for 2 Fall 2008 students

## 5. Presentation of Findings

The instructor used several types of screencasts to supplement course material, namely, lecture recordings; homework, quiz, and exam solution screencasts; and mini-lecture screencasts that focused on unclear concepts students identified through a technique comparable to the "muddiest point" classroom assessment. Since the lecture recording screencasts uses a different system, we are unable to determine which students used these recordings. But we do know that MSE220 in Fall 2007 had the highest usage of lecture recordings in the entire College of Engineering at the University of Michigan, with 826 total viewing hours (an average of over 5 hours per student enrolled in the class). For the homework, quiz, and exam solutions, as well as the "muddiest point" screencasts, we are able to correlate student usage levels with their background and performance. The bulk of our analysis will focus on these resources.

In general, students used the homework solution screencasts the most (Fall 2007: 2531 website hits, Fall 2008: 2604 website hits). The students visited the "muddiest point" screencasts or mini-lectures 1385 and 1405 times in Fall 2007 and Fall 2008, respectively. Students visited the quiz and exam solution screencasts the least (Fall 2007: 328 website hits, Fall 2008: 355 website hits). Since the exams are not cumulative, this fact may have contributed to this low student usage. These numbers highlight the frequency that students access a particular resource it does not indicate *how* students use the resources, nor the duration. In section 5.1, we explore student usage in more detail. In section 5.2, we analyze student usage patterns to determine general characteristics of particular subgroups. Section 5.3 correlates student performance and usage. And finally, it is important to note that students rarely reported experiencing any technical difficulties that prevented them from viewing the screencasts for both terms. For example, the majority of students (68%) during the Fall 2008 semester reported having technical problems "almost never."

Recall that our research questions are as follows:

- How do students use varying kinds of screencasts?
- Which students use screencasts?
- Does student use of screencasts affect learning, in terms of self-report and/or in terms of exam performance?

### 5.1. How do students use varying kinds of screencasts?

To learn about student perceptions of the various kinds of screencasts, we asked them to describe their experiences during an end-of-term survey for Fall 2007 and Fall 2008. Out of the 144 students who were directed to the survey in Fall 2007, 72 students responded (with 52-57 students responding to most questions). The response was higher for Fall 2008 such that 143 students out of 211 who were directed to the survey responded (with 116-123 students responding to most questions). For both terms, we asked students directly about their experiences with the muddiest point/unclear topics screencasts and explanations of homework, quiz, and exam solutions. For Fall 2008, we asked them to explain their experiences with lecture recordings and we begin our discussion with this topic.

#### 5.1.1 Lecture Recordings

During Fall 2008, 36 lectures were recorded and placed on the course management website. When students were asked to give the single best description of how they typically use lecture

recordings, 46% of 125 students who responded to this question watched the entire video from start to finish. Lectures were approximately 50 minutes long. Only 18% of students re-watched certain segments based on their notes, 16% of students went to specific points in lecture to review, 15% of students watched large chunks looking for information, and only 5% of students browsed around. With the use of lecture recordings, nearly 66% of Fall 2008 respondents indicated that reviewing lecture and/or notes from lecture "slightly increased" or "greatly increased." Further, we asked students to indicate their level of agreement with the following statement, "I have a deeper understanding of the material discussed in lecture because of the lecture recordings." Forty-six percent of the 126 students who answered this question "strongly agreed" and 43% of students "somewhat agreed." One student from Fall 2008 described using lecture recordings as follows:

> "…online lectures benefit students because there is always the option [to listen] online if the instructor goes too fast. I am a pretty good note taker and don't have a problem with paying attention to the professor and taking notes but I know some people find this very difficult. Everyone has different learning styles and for the students who need to really listen the first time a topic is presented, the online lectures are a great tool for taking notes at a later time."

When we asked students to indicate all the reasons they have for looking at the recorded lectures, 124 students responded as follows: exam study tool (75%), study supplement (65%), replace live lectures (62%) and fill in gaps in notes (62%). Nearly half the students used it to work on assignments (46%), but only a small fraction used it as a study group resource (3%).

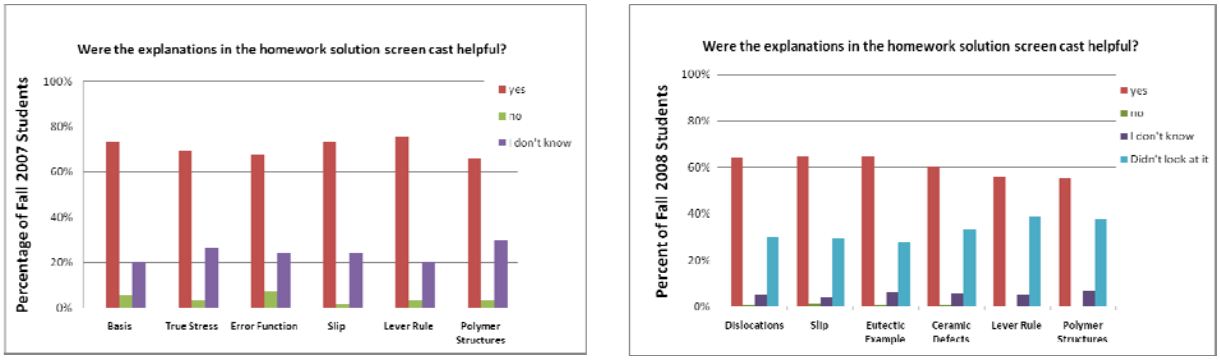
One student said, "I think it was a great reference to revert back to lecture notes even when I attended class." With regards to a survey question focusing on attendance, 43% of the 127 students who responded in Fall 2008 indicated that their attendance to lectures remained unchanged and 41% said their attendance slightly decreased.

### 5.1.2 Explanations of Unclear or "Muddiest Point" Topics

In Fall 2007, the professor created 6 muddiest point screencasts to address student misconceptions. The following year, the students were able to access 9 screencasts (6 newly created for Fall 2008 and the remaining from Fall 2007). Of the students who viewed the screencasts and responded to our end-of-term survey, 53% -62% of students in Fall 2007 and 51%-67% of students in Fall 2008 found the screencasts to be "very helpful" or "extremely helpful." Like the lecture recordings, 64% of students viewed the screencast from start to finish (N=86/107). Only 16 out of 107 respondents said they "went to specific points to review" (15%). Students mostly used the "muddiest point" screencasts as a study supplement (81%, N=89/110) or more specifically an exam study tool (76%, N=83/110). Finally, 40% of students strongly agreed that they had a deeper understanding of the lecture material after viewing the "muddiest point" screencasts (N=46/115). One Fall 2007 student said, "The screencasts cleared up confusion, and reinforced the ideas presented in lecture." Another student in Fall 2008 said, "I felt that the screen casts were extremely helpful. They would add more time to specifically clarify things that were murky in lecture. It also helps because it doesn't slow the whole class down if a specific topic is difficult for some people."

### 5.1.3 Explanations of Homework, Quiz and Exam Solutions

To learn more about the explanation of solutions, we asked students to think about 6 different topics that were covered in the term. They rated their difficulty with the material and whether the explanation of assignment solutions (homework and quiz/exam) were helpful to them. There were 9 and 12 homework solution screencasts in Fall 2007 and Fall 2008, respectively. There were 2 quiz solution and 2 exam solution screencasts for both terms. We asked students, "Were the explanations in the homework solution screencast helpful to you on a particular topic?" In both terms the majority of students found the screencasts helpful (Figure 4) even if they did not find a topic difficult (Figure 5). One Fall 2007 student said, "I feel that this is one of the great things about this class. I've never had a class where the answer key is worked out right in front of you. It really helps to understand the material and the steps needed in each type of problem."

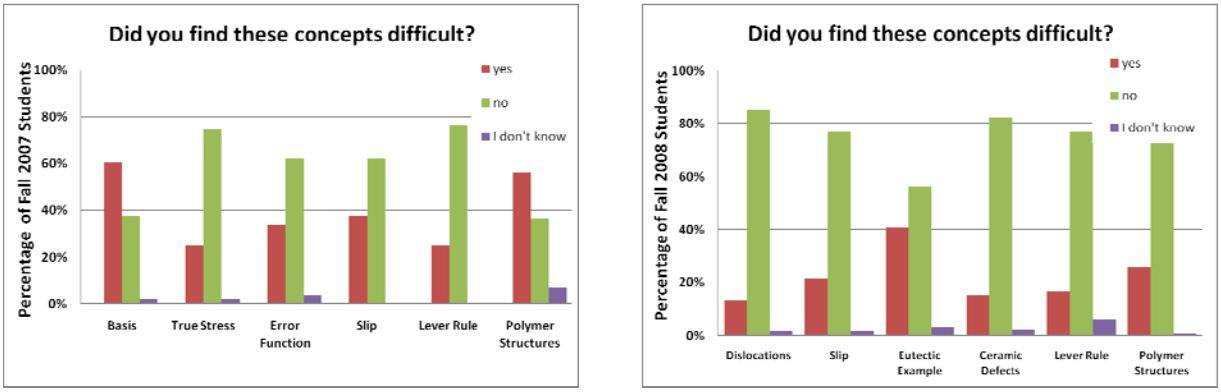



(a) (b)

Figure 4. Percent of respondents that found homework solution screencast helpful for (a) Fall 2007 and(b) Fall 2008

(Note: Fall 2008 students had the option of choosing "didn't look at it" for this question.)

Like the other screencasts, Fall 2008 students tended to watch the homework solution screencasts from start to finish (36%, N=40/116). Twenty-five percent of the 116 student respondents re-watched certain segments based on their homework response. Students primary reasons for watching homework solutions screencasts were as an exam study tool (84%, N=96/115) or more generally, a study supplement (77%, N=88/115).




(a) (b)

Figure 5. Number of respondents that found particular concepts in MSE difficult in (a) Fall 2007 and (b) Fall 2008

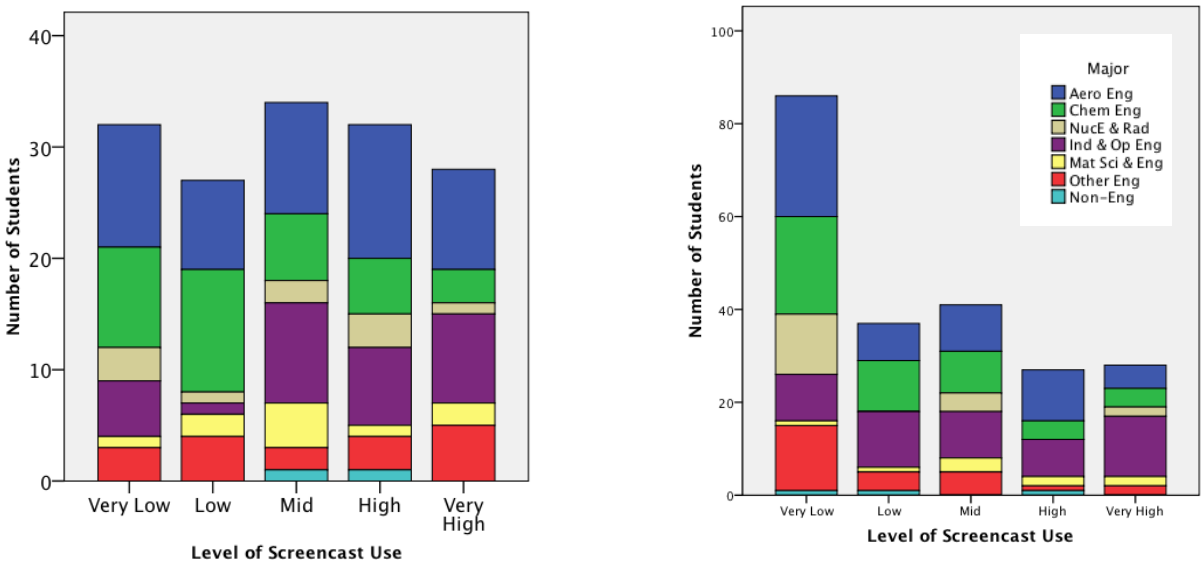
Of the topics mentioned in the survey, 45-57% of the students found the quiz solutions screencasts helpful. One Fall 2008 student said, "The quiz solution screencasts allowed me to clarify concepts I didn't fully understand before the quiz, and helped me master them before the exam."

### 5.2. Which students use screencasts?

Recall that one of our goals is to determine if there are particular subgroups that might find additional online resources useful in a large lecture survey course. So this section focuses on usage levels generally, but highlights differences by academic background, class level, gender, race/ethnicity, and cumulative GPA.

During both terms, students had the opportunity to view at least 19 screencasts comprising of homework solutions, quiz/exam solutions, and "muddiest point" topics. We define our usage levels as follows: very low (1-10 website hits), low (11-20 website hits), medium (21-30 website hits), high (31-40 website hits), and very high (more than 41 website hits). The total website hits for Fall 2007 and Fall 2008 was 4244 and 4364, respectively. This represents a decrease in the usage for Fall 2008 when you factor in the larger student population and the increase in available resources. There were 16 students (out of 219) in Fall 2008 who never accessed any of the screencast, while there were only 4 students (out of 154) in Fall 2007. We believe that the course structure during Fall 2008, where the students reviewed the learning objectives on a regular basis and took self assessment quizzes to evaluate their confidence in achieving these goals may be a factor. Students may not have felt that they needed to view the screencast based on the learning objective for a particular chapter.

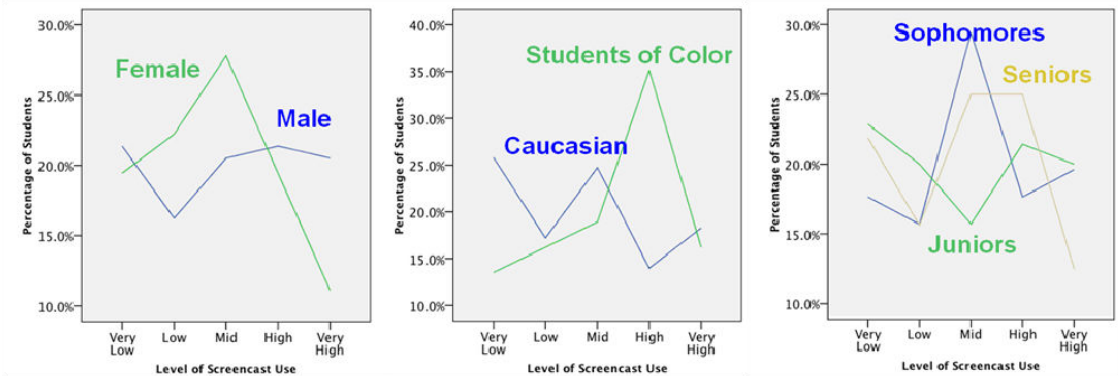
The distribution of usage varies for each of the majors represented in the course for both terms (Figure 6). For instance, in Fall 2007 and Fall 2008 Chemical Engineers tend to be low users of the screencasts. In comparison, Industrial and Operations Engineers tend to be high users, especially in Fall 2007. This may be because Chemical Engineering is most closely related to Materials Science compared to the other disciplines, and Industrial Engineering is the least related. In Fall 2008, the usage levels for Industrial and Operations engineering students was more evenly distributed. Materials Science majors are intermediate users for both terms, perhaps because they are more junior compared to the rest of the class.




(a) (b)

Figure 6. Screencast usage by major (not including lecture recordings) for (a) Fall 2007 and (b) Fall 2008

Analysis also shows that different groups of students use the screencast at different rates based on gender, race, and class level in Fall 2007. In that semester, the distribution of usage is strikingly different for males than for females. Female students tended to be intermediate users, whereas the usage for males tended to be equally distributed between low, medium, and high users (Figure 7a). Students of color tended to be high users of screencasts (Figure 7b). In Fall 2007, seniors were more likely to be medium-to-high users, sophomores were most likely to be intermediate users, and juniors were more likely to be low screencast users (Figure 7c). Other studies have determined that lecture recordings are valued by a subset of students, as indicated by differential patterns of student use.[7, 13]

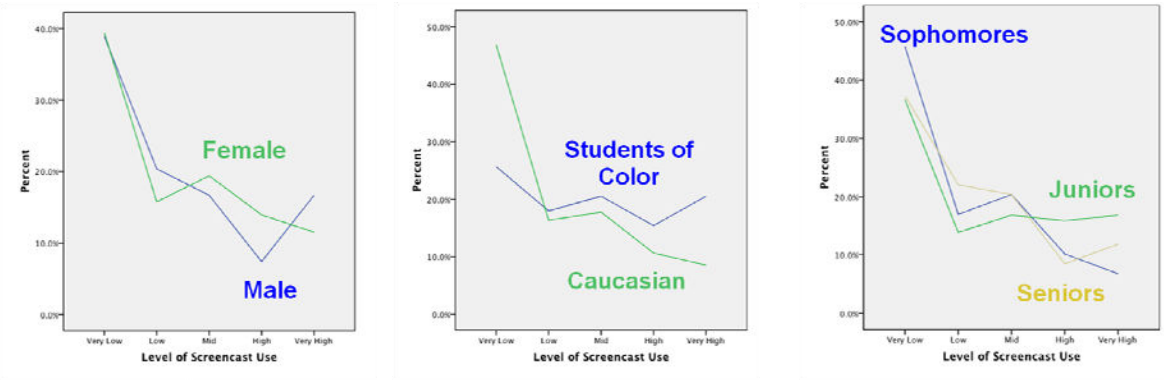



(a) (b) (c)

Figure 7. Screencast usage of students for the Fall 2007 cohort by (a) gender, (b) race and (c) class level

In Fall 2008, when the instructor became more transparent about the learning goals for each class unit, our analysis shows that different groups of students had similar distribution rates of their

screencast usage based on gender, race, and class level. Unlike the Fall 2007, the usage pattern for males and females were similar (Figure 8a). Like Fall 2007, students of color are more likely to be high users of screencasts (Figure 8b). Further the usage pattern for students of color tended to be more evenly distributed and there is a statistically significant positive correlation between screencast usage and race ($p \leq 0.01$). The distribution by class level in Fall 2008 revealed a comparable trend between sophomores, juniors, and seniors. The bulk of the users were low, but a higher percentage of juniors were high-to-very high users in Fall 2008 in comparison to sophomores and juniors. This is a different usage pattern in comparison to Fall 2007 (Figure 8c).

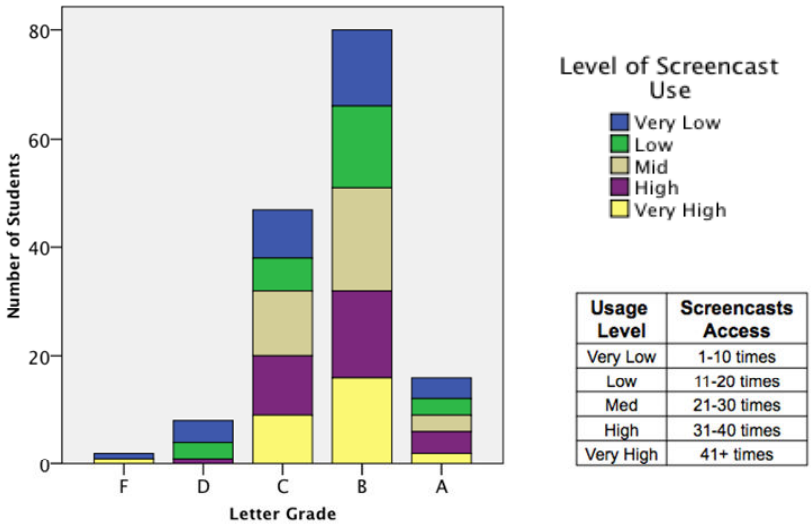



(a) (b) (c)

Figure 8. Screencast usage of students for the Fall 2008 cohort by (a) gender, (b) race and (c) class level

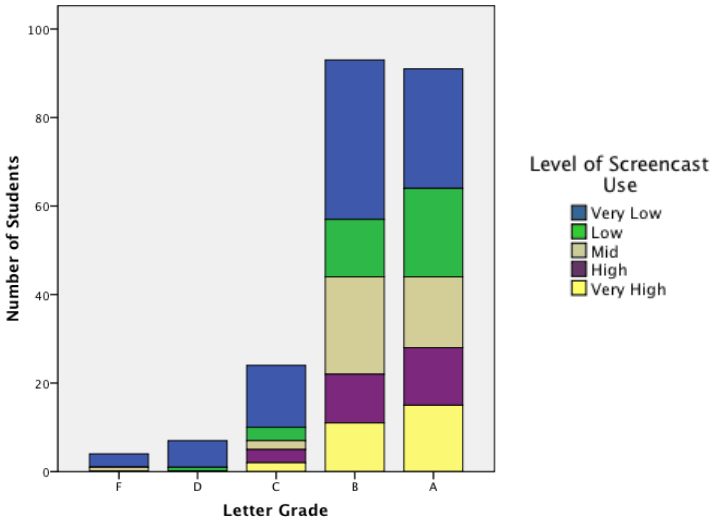
**5.3 Does student use of screencasts affect learning, in terms of self-report and/or in terms of exam performance?**

Screencasts usage was examined in terms of the overall performance of the students for Fall 2007 (Figure 9a) and Fall 2008 (Figure 9b). Fall 2007 data shows that students at all performance levels, not just high achievers, used the screencasts to some degree. In general, students performed well on the exam questions that were associated with screencasts, having an average grade of 80% which is comparable to, the average score for most questions. However, there was no statistically significant correlation between screencast usage and performance in Fall 2007. In contrast, there was a statistically significant positive correlation ($p \leq 0.01$) between student screencast usage and final grade in Fall 2008. In general, students' exam scores and final grades were higher in Fall 2008 in comparison to Fall 2007. For example on the first exam students scored 65 out of 100 points for Fall 2007, but scored 88 out of 100 points for Fall 2008.




| Usage Level | Screencasts Access |
|---|---|
| Very Low | 1-10 times |
| Low | 11-20 times |
| Med | 21-30 times |
| High | 31-40 times |
| Very High | 41+ times |

(a)




(b)

Figure 9. Screencast usage with the grade distribution for (a) Fall 2007 and (b) Fall 2008

## 6. Conclusion and Future Work

Integrating online resources like lecture recordings and supplemental screencasts have the potential to support students as they study outside the classroom and reinforce concepts presented inside class. Students overwhelmingly perceive theses resources to be helpful to them. One Fall 2008 student described using screencasts as follows:

> "I love the lecture screencasts. I watch all the lectures over and the [homework solution screencasts] before each exam and have done average or above. I also learned more by watching it over again and being able to pause at the concept checks, do the problems and then check if I got the correct answer. As a senior

interviewing a lot this semester, these lecture screencasts caught me up after being out of town for interviews. I wish every class had screencasts."

Among the more dramatic findings of this research from Fall 2008 is the statistically significant positive correlation between the students who viewed the screencasts and their final grade. This suggests that our continued analysis should look more closely about the student use data and their variations. An additional implication of the research to date is to further examine student differences (e.g. gender, race, academic background, class level, etc.). Our results suggest that particular groups of students may use the resources more often depending upon their academic or social background.

In the course context, further examination is needed to think about variations from the instructor's side. As part of the process for analyzing the research results, the instructor realized that presentation of course materials, with these innovations, resulted in better alignment of the learning objectives, methods, and assessments. Thus, an unexpected consequence of the innovation and research has been to affect the teaching strategies that help students link the various course materials. We will continue this work by analyzing this impact on specific course topics.

## 7. Acknowledgements

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