

## **AC 2009-1382: LEVERAGING SCREEN CASTS TO STRATEGICALLY CLARIFY UNCLEAR MATERIAL-SCIENCE CONCEPTS**

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Joanna Millunchick is Associate Professor of Materials Science and Engineering, and is affiliated with the Applied Physics Program and the Michigan Center for Theoretical Physics at the University of Michigan. Prior to joining UM in 1997, Millunchick was a Postdoctoral Fellow at Sandia National Laboratories. She received her B.S. in Physics from DePaul University in 1990, and her Ph.D. in Materials Science and Engineering from Northwestern University in 1995, where she held the GE fellowship. Her general research interests involve manipulating matter and particles on the nanoscale in order to enable the design of new electronic materials for optoelectronic and microelectronic applications. In 2004 she spent her sabbatical at Northrop Grumman and UCLA, where she worked on the characterization of GaN-based microelectronics using X-ray diffraction techniques. Millunchick's teaching interests include introductory materials science courses taken by students from across the college, and core materials science courses taken by materials science undergraduates. For the past few years, she has conducted pedagogical research examining the efficacy of internet-based resources in student learning. Prof. Millunchick has received several awards, including the NSF CAREER award and the Sloan Foundation Fellowship.

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### **Lindsay Shuller, University of Michigan**

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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.

# Leveraging Screencasts to Strategically Clarify Unclear Material Science Concepts

## Abstract

This paper presents findings from a study prompted by the desire to enhance students' conceptual understanding of material science and engineering concepts in a large lecture introductory course. The pedagogy examined focuses on the use of online resources which students use to study selectively and at their own pace. Screencasts, recordings that capture audio narration along with computer screen images, are one such resource that can provide the rich, multimedia structure of a classroom lecture that engages students' different learning styles. This paper compares strategies that instructors used in two iterations of the same course to identify topics on which to make supplemental screencasts, to help students understand difficult concepts. The paper further examines how screencasts in themselves may and may not contribute to student learning outcomes.

The methodology is as follows. In a first course iteration, students identify concepts or topics that they did not fully understand for a unit by turning in index cards at the end of class. This approach is inspired by a classroom assessment technique advocated in faculty development literature, "The Muddiest Point" assessment.<sup>1</sup> Not surprisingly, the concepts students identified are topics that students have historically found difficult in this course (i.e. basis, true stress, error function, slip, lever rule, and polymer structures). However, survey data show that students reported only two topics were difficult (i.e. basis and polymer structures). Surprisingly, survey results indicate that the majority of students responding found all of the screencasts helpful regardless of whether they found a concept difficult or not. Other data suggest that the impact on student learning could be even greater, as both faculty and students learn to utilize this new resource. Addressing these concerns, in a second iteration of the course, students answer an online survey and self-report their comfort level with various course topics. These questions specifically align with the learning objectives of the unit. In this iteration, the professor develops a supplemental screencast when 30% or more of students identify a concept or topic as being unclear. This paper compares the results of these two approaches.

## 1. Introduction

Introduction to Materials and Manufacturing (MSE220) is a large survey course that poses distinct challenges for teaching and learning at the University of Michigan. MSE220 is a gateway course for MSE students but it is also a technical elective for students in other departments, with Aerospace, Chemical, and Industrial and Operations Engineering students comprising the majority of the class. Students also vary in their class standing from sophomores through graduating seniors, as well as in gender and ethnicity. Adding to this student diversity is the complexity of the survey course: the breadth of topics covered requires that students attain different kinds of conceptual and process understanding to grasp the varied topics.

This paper documents the first part of a series of course-based studies initiated by the professor of the course (Millunchick) to enhance student understanding, where the instructor saw that student performance was not, on the whole, meeting expectations. The professor began creating

screencasts, i.e., mini-lectures to explain key concepts and to review homework solutions, and posting these as supplemental resources for students. To determine the impact of these resources, the professor worked with a team of consultants from the University of Michigan's Center for Research on Learning and Teaching (Pinder-Grover and Bierwert), and a graduate student instructor (Shuller) using a small grant from the teaching center. Together, we studied student use of the resources and later began to probe the impact on student learning.

In general, the research design involves the students identifying key concepts that are difficult, the professor creating supplementary materials to clarify these concepts, and the co-authors analyzing the students' use of these materials and working to find ways of determining whether the use of screencasts made a difference. Focusing in on a particular topic – polymer structures – was extremely helpful in testing the impact of supplementary materials on student learning. In addition, the authors developed a strategy to analyze student learning and screencast use based on their major, class standing, gender, and ethnicity.

Thus the study provides a model for assessing the potential of web-based supplementary materials. More specifically, we analyze student learning outcomes for particular topics and examine whether the use of new resources impacts students differently according to their academic or demographic group.

## **2. Course Background**

This study investigates student use of screencasts 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 prerequisite for this course is one semester of either inorganic or organic chemistry. The course covers chapters 1-18 of Callister's *Materials Science and Engineering: An Introduction*.<sup>2</sup> The professor has historically posted lecture outlines, as well as lecture recordings for students to study outside of class. The principle instructor delivers lectures three times a week. Smaller discussion sections (approximately 30 students) meet once a week with graduate student instructors, who review example problems designed to aid the students with completing the weekly homework assignments. There are three quizzes, given during the discussion period, and three exams, given during the regular lecture time. The principle instructor uses consultants from the university's teaching center to gather student feedback in the middle of the term.

## **3. A Note on Screencasts**

A screencast is a movie that captures the activity on a computer screen with real time audio commentary.<sup>3</sup> The computer screen material can range from PowerPoint slides, to notations made on a Tablet PC, to screen shots of web sites, and other uses. To provide supplementary information for students in a university course, the instructor uses a software program that saves recorded audio and video as one file (e.g. a "podcast") and posts the resulting file to the course management site for students to replay (Figure 1). Used properly, this approach can be a rich supplementary resource because it includes written, audio, and video elements, thus reaching students with many different learning styles. Screencasts may be fast forwarded, rewound and

paused as necessary. Also, they are accessible to students at any time of day (in contrast to office hours, live chats, etc.).

It is worth noting that in this course, all the in-class lectures are recorded on a system in the classroom, which captures a video of the professor as well as the audio and computer screen visuals. Further, screencasts were created to explain homework, quiz, and exam solutions. “Muddiest point” screencasts were also created to explain topics that students identified as unclear or confusing.<sup>131</sup> All of these screencasts are posted to the course management site and provide an additional resource to students.

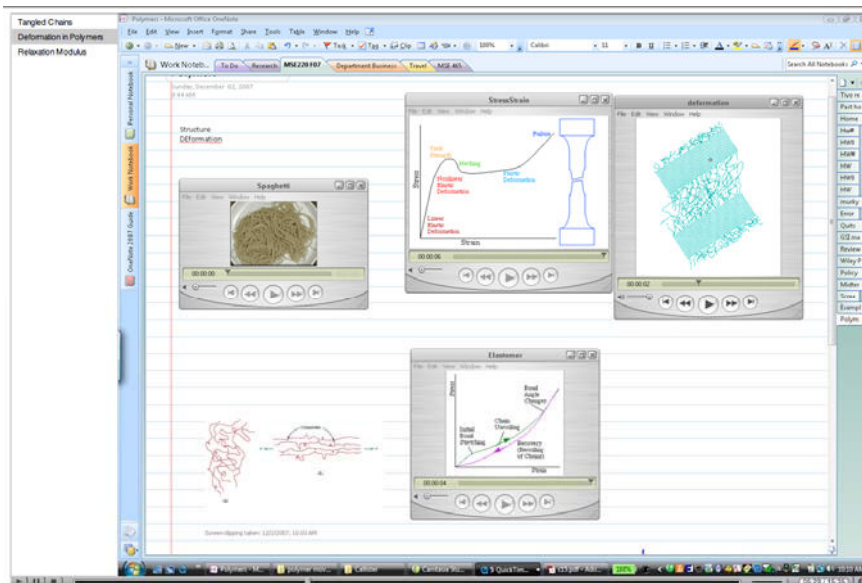


Figure 1. Screen-shot of a muddiest point screencast

#### 4. Student Demographics

Students in MSE220 were comparable in terms of the gender, racial, academic, and class level composition during Fall 2007 (N=154) and Fall 2008 (N=219). For both terms, the student population was at least 75% male and 60% Caucasian. The majority of students in the course during both terms were from Aerospace Engineering, Chemical Engineering, and Industrial and Operations Engineering (>70%). Students majoring in Material Science and Engineering comprise of a small fraction of the student population for both terms (<7%). In general, students had comparable average GPAs (3.1), ACT scores (29), and SAT scores (1337). Finally, in both terms nearly half of the students were juniors.

#### 5. Methodology

To explore the impact of screencasts on student learning, we first developed an online end-of-term survey to assess students’ perceptions of these resources and obtained approval from our university’s Institutional Review Board. With respect to the “muddiest point” screencasts, the survey asked students about the difficulty of particular concepts, how they used the screencasts in general, and whether the resource was helpful. 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. The quantitative analysis of our data was the primary objective. We report descriptive statistics and provide illustrative quotes to further illuminate key numerical findings.

In addition, the authors received student demographic data from the registrar's office and student usage from the college's technology support department. The instructor also designed the quiz and exams questions to test whether or not specific concepts were understood by the students. With all this information, we investigated the correlation between logged student use and student performance on assignments (final grade, exams, quizzes, homework).

## **6. Presentation of Findings**

Generally, there were several trends related to how students used the various types of screencasts that were created for the class (i.e. "muddiest point" and solutions to homework, quizzes, and exams). Student usage varied by academic background such that Chemical Engineers tended to be low users, while Industrial and Operations Engineers tended to be high users (especially in Fall 2007). We attribute this difference to the fact that topics covered in Chemical Engineering are more similar to Material Science and Engineering than Industrial and Operations Engineering. Further juniors were less likely to use screencasts in comparison to sophomores. Further, students of color tended to use screencasts more often.

With these trends in mind, we explore the two approaches to the "muddiest point" screencasts for Fall 2007 and Fall 2008 in the following sections. For both terms we highlight student perceptions of the screencasts and describe how the usage levels related to student performance. For Fall 2008, we also highlight student performance on topics related to polymer structures for a particular homework problem and their resulting performance on a final exam question that the professor aligned with the content in the polymer structures screencast.

### **6.1 "Muddiest Point" Design#1: Data Collection Using Index Cards**

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. This process is comparable to the "muddiest point" classroom assessment technique.<sup>1</sup> A screencast based upon the responses was designed in order to provide additional explanations, worked-out problems, or examples as appropriate at the end of each chapter. No more than 15% of the students identified any one problematic topic in any unit, but those identified were concepts that students have historically found difficult in this course (e.g. basis, true stress, error function, slip, lever rule, and polymer structures). In all, 6 "muddiest point" screencasts were developed. The responses to the index card surveys varied widely, and were occasionally extraneous. Also, the response rate was less than 30%.

### 6.1.1 Student Perception of “Muddiest Point” Screencasts Design #1

Out of the 144 students who were directed to the end-of-term survey in Fall 2007, 72 students responded (with 52-57 students responding to most questions). For four of the six screencast topics (e.g. basis, true stress, error function, and polymer structures), the survey asked students, “How helpful was the screencast?” The responses show that students believe the “muddiest point” screencasts were helpful (Figure 2), and 13% - 16% of the students found them “extremely helpful.” When asked about the difficulty of these topics, majority of the respondents ( $>60\%$ ,  $N \geq 35/57$ ) found only two of the six topics to be difficult (basis and polymer structures). Yet, they still viewed the screencasts for almost all topics and found them to be helpful. One student described his/her concern about basis, which is the smallest repeating unit in a crystal lattice, as follows:

“Basis seemed to be a simple concept at the beginning when we had only one element involved. However when we moved onto the materials with somewhat more complicated [bases], the whole concept of basis became confusing mainly because I just could not visualize those molecular structures with a basis comprising of multiple elements. The screencast, however, helped to clarify the concept.”

In addition, we asked students whether they would have liked screencasts on slip and lever rule, two topics that students had trouble with in the past. Approximately 62% of students indicated that they would have liked a screencast on slip ( $N=34/55$ ), but only 43% wanted a screencast on the lever rule ( $N=23/54$ ). This response provides ideas for future topics that may be confusing to students. Six of the 7 respondents did not name additional topics (86%) when asked, “Are there any other topics you had difficulty with, where an additional resource might have been helpful?” The one remaining student expressed the need for supplemental material on ceramics. More suggestions included the use of practice problems and screencasts to supplement guest lecturers.

In general, students identified the following uses for screencasts: to clarify misunderstandings, to supplement the lecture material, and to review for exams. One student commented, “Screencasts are great because it shows topics that the Professor finds important and is a great resource to use to study for the exam. Also, even if I understand the concept, hearing important material one more time in a new way is always extremely helpful.”

Interestingly, the majority of the students in Fall 2007, did not view the polymer structures screencast, which was the final screencast posted for the semester (Figure 2). We attribute this result to the timing of the survey administration and the posting of the screencast. One student expressed this point by saying, “Polymer structures released recently, not had the time yet. The rest were helpful!!!!”

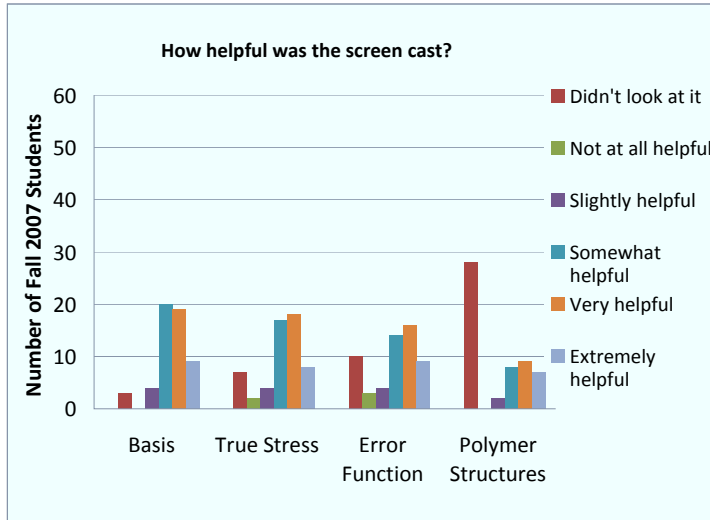
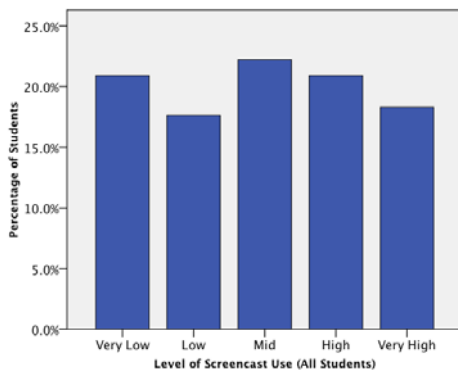


Figure 2. Helpfulness of the muddiest point screencasts for Fall 2007 represented by the number of respondents

### 6.1.2. Student Usage and Performance with “Muddiest Point” Screencasts Design #1

In this section we define student usage levels and relate this information to their course performance as indicated by their final grade. We define the students’ overall usage levels based on the number of times they viewed all types of screencasts (“muddiest point,” homework solutions, and exam/quiz solutions). We describe usage levels as “very low” for 1-10 times, “low” for 11-20 times, “medium” for 21-30 times, “high” for 31-40 times and “very high” for more than 41 times (Figure 3). For Fall 2007, the percentage of students who accessed screencasts was nearly equal for all usage levels (Figure 3).



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

Figure 3. Screencast usage levels for all types during Fall 2007 (homework, quiz/exam solutions, and muddiest point)

In general, students did quite 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. The usage of the screencasts from the Fall 2007 cohort was examined in terms of the overall performance and shown in Figure 4. Students at all performance levels used the screencasts with the course to some degree. However, the analysis of variance (ANOVA) shows no statistically



significant correlations. This result raises some questions about the effectiveness of the screencasts to clarify student misconceptions and ultimately impact student performance. In particular, for the “muddiest point” approach, we decided to implement a more refined course design that would make the course learning objectives more transparent to students and provide a more systematic approach to assessing unclear topics.

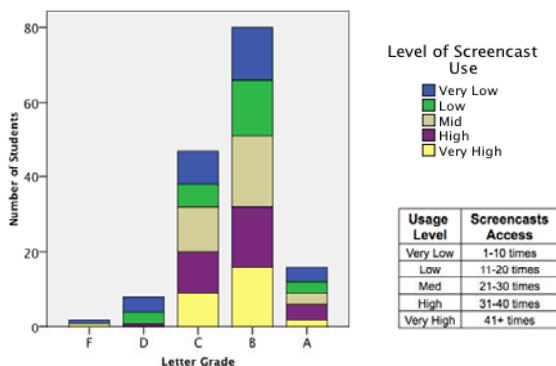


Figure 4. Screencast usage with the grade distribution for the F07 cohort

## 6.2 “Muddiest Point” Design#2: Data Collection Using Required Online Surveys

The initial data collection approach for the “muddiest point” screencasts resulted in students responses that varied widely and were occasionally extraneous for Fall 2007. Also, the response rate was low. Therefore, a second iteration was conducted in Fall 2008 in which the course required students to answer an online survey and self-report their comfort level with various course topics. Although this survey was a required part of class it only constituted 3 out of 100 points of the final grade. These questions were specifically aligned with the learning objectives for each unit. From these self-reports, screencasts were developed based on 30% or more of students who identify a concept or topic as being unclear.

The response rate for the surveys ranged between 63% and 94%, whereas the response rate for the index card method was on the order of 15%. On most surveys students expressed confidence in their understanding of the learning objectives, yet expressed interest in having a screencast on the same learning objective. Therefore, screencasts were developed for topics that at least 30% of students did not feel confident answering. The typical format of the self-assessment surveys were stated as follows: “I feel confident with ...”.

A total of 9 screencasts were provided to students, 3 of which were developed in past semesters. The following materials science and engineering concepts warranted screencasts: structures, bonding and properties, Burgers vector, dislocations, slip, an example on eutectic phase diagrams, deformation in ceramics, ceramic structure, and polymer structures. The bonding and properties, Burgers vector, and polymer structures screencasts were developed for the Fall 2007 course and made available to students during Fall 2008. Screencasts were posted soon after the end of the unit and before quizzes that tested on that topic. This is different from Fall 2007, where the instructor posted screencasts closer to exam time.

### 6.2.1 Student Perception of “Muddiest Point” Screencasts Design #2

Out of the 211 students who were directed to the survey in Fall 2008, 143 students responded to the end-of-term survey (with 116-123 students responding to most questions). The Fall 2008 survey asked students about the difficulty of the following concepts: dislocations, slip, eutectic example, ceramic defects, lever rule, and polymer structures. The instructor created new “muddiest point” screencasts for all topics except for lever rule and polymer structures. No screencast was made for lever rule (recall that Fall 2007 students indicated that this resource was not necessary). In addition, the polymer structures screencast that the instructor created in Fall 2007 was uploaded again in Fall 2008.

Like Fall 2007, the majority of students (56%-85%) did not find these topics difficult. Fourteen of the 26 respondents did not name additional topics (54%) when asked, “Are there any other topics you had difficulty with, where an additional resource might have been helpful?” Named topics include concepts such as corrosion and electronic properties of materials.

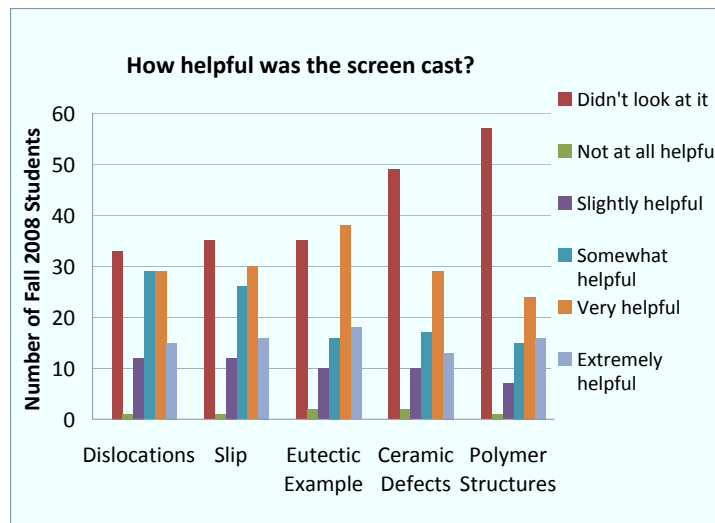


Figure 5. Helpfulness of the muddiest point screencasts for Fall 2008 represented by (a) the number of respondents and (b) the percentage of respondents.

For the students who viewed the “muddiest point” screencasts, the responses show that majority of students (between 51% - 67%) believe the “muddiest point” screencasts are “very helpful” or “extremely helpful” (Figure 5). One student said, “[The] screencast with an example on eutectic phase diagrams helped me better understand the concept and apply it to the homework.” Another student exclaimed, “The [muddiest point] screencasts were amazing! They were clear, precise, and straight to the point. I strongly encourage all professors to consider using them for their classes.” Between 28% - 39% of students reported they did not view a particular screencast, which is a significant departure from Fall 2007. Of the 6 remaining students who explained their reasons for using the resources less often, some students simply chose not to view online content (2), others did not feel as though additional support was necessary (2), one student watched the screencast only if the topic was confusing (1), and one student did not remember to access the resources (1).

We asked the Fall 2008 cohort to describe more specifically how they used the “muddiest point” screencasts. Sixty-eight out of 107 students said they “watched entire video from start to finish” (64%) when asked, “Which is the single best description of how you typically use [muddiest point] screencasts?” Only 16 out of 107 respondents said they “went to specific points to review” (15%). In addition, we asked them to highlight their motivation for viewing the muddiest point screencasts. When asked, “What are the reasons you have for looking at the [muddiest point] screencasts?,” students mostly used these resources as a study supplement (81%, N=89/110) or more specifically an exam study tool (76%, N=83/110).

When asked for their level of agreement with the following statement, “I have a deeper understanding of the material discussed in lecture because of the ‘muddiest point’ screencasts,” 50% of the 115 respondents “somewhat agreed,” while 40% of respondents “strongly agreed.”

### 6.2.2 Student Usage and Performance with “Muddiest Point” Screencasts Design #2

There was a significant departure in terms of student usage levels for all types of screencasts in Fall 2008. For example, students who accessed screencasts 1-10 times (very low) comprised of 40% of the enrollment, while students who accessed the screencasts more than 31 times (high and very high) comprised of 25% of students. This differs from Fall 2007 because the usage levels for all categories during this term were approximately 20% (Figure 3). Further, nearly 8% of students in Fall 2008 never accessed the screencasts.

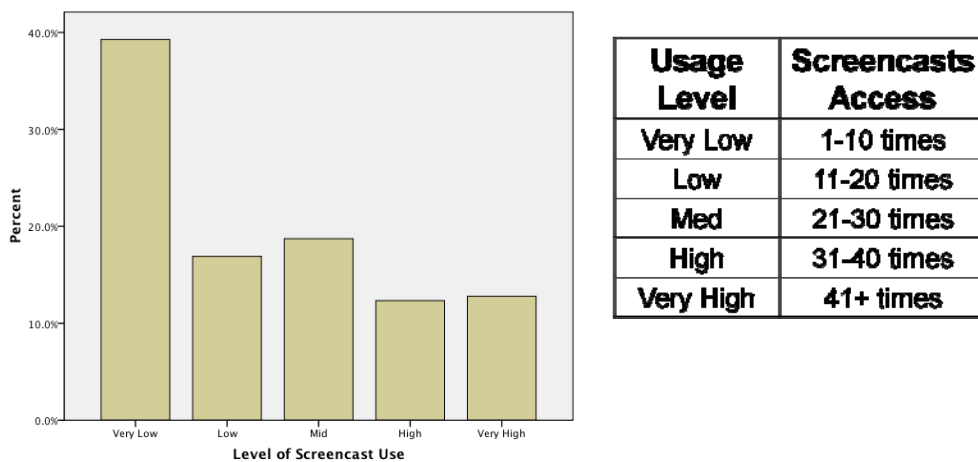


Figure 6. Screencast usage levels for all types during Fall 2008 (homework, quiz/exam solutions, and muddiest point)

In terms of student performance, the Fall 2008 cohort had a statistically significant positive correlation between the final grade and screencast usage ( $p \leq 0.01$ ). This result is quite different from the Fall 2007 cohort even though the cumulative GPAs and general composition (i.e. gender, race, class level, and academic background) of both cohorts are comparable. Figure 7 shows the grade distribution for the Fall 2008 cohort, highlighting their level of screencast usage.

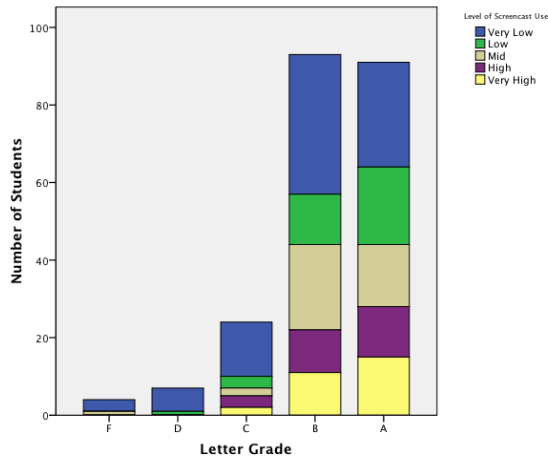


Figure 7. Screencast usage with the grade distribution for the Fall 2008 cohort

### 6.3. Case Study: Polymer Structures Homework Analysis

To further analyze the impact of the muddiest point screencasts, we focus on one concept, polymer structures. In this section, we highlight the assigned homework problems on this subject. Further, we examine the final exam problem that focused directly on polymer structures to determine if students who viewed the screencasts were more able to answer the question by demonstrating a deeper understanding of the concept.

As previously mentioned, the screencasts were posted between homework assignments and quizzes or exams on the same subjects. Therefore, a comparison of homework, quiz, and exam performance is used to determine the efficacy of the screencasts. The focus of this analysis is on the efficacy of the polymer structures screencast. The polymer structures screencast was produced in response to student requests to clarify three concepts on polymers: polymer conformation, deformation in polymers, and the physical meaning of the relaxation modulus. In each instance, the instructor coupled short oral reviews of the topics with schematics and flash animations to illustrate the underlying physics. There was also a very strong emphasis on the role of atomic structure in each of the review topics.

Figure 8 provides a distribution of how many times the Fall 2008 cohort accessed the polymer structures screencast. The majority of students (72%, N=159) did not view the polymer structures screencast, while nearly 27% of students (N=60) viewed the screencast at least once. The low usage of the polymer structure screencast could be contributed to the extra lecture covering example problems for this subject. The lecture recordings are archived for this course and students are able to use them as a study tool, as well.

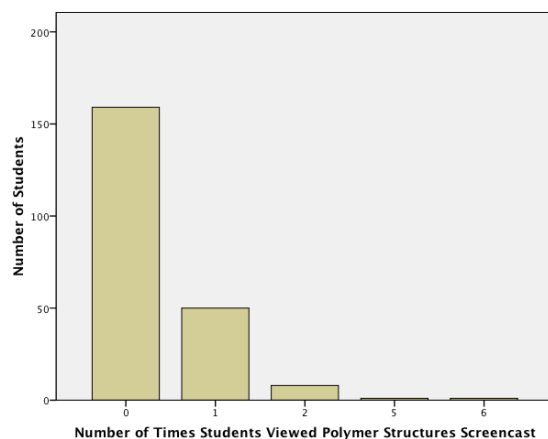


Figure 8. Polymer Structures Screencast usage for the Fall 2008 cohort

### 6.3.1 Polymer Structures Homework Analysis

In preparation for the quiz, students were asked the following questions on polymer structures from Chapter 14 of Callister.<sup>2</sup> Homework problem 14.23 states:

For each of the following pairs of polymers, do the following: (1) state whether one polymer is more likely to crystallize than the other; (2) if it is possible, note which is the more likely and then cite reasons(s) for your choice; and (3) if it is not possible to decide, then state why.

- (a) Linear and atactic poly(vinyl chloride); linear and isotactic polypropylene.
- (b) Linear and syndiotactic polypropylene; crosslinked *cis*-isoprene.
- (c) Network phenol-formaldehyde; linear and isotactic polystyrene.
- (d) Block poly(acrylonitrile-isoprene) copolymer; graft poly(chloroprene-isobutylene) copolymer.

The percent of students who correctly answered the homework problem was quite different for the parts (a, b, c, and d). In part a, the correct answer is that you cannot tell which polymer will crystallize more readily. Only 40% (N=82) of students who turned in their homework answered part a correctly. For parts b, c, and d, where one polymer does crystallize more readily than the other, 93% (N=188), 86% (N= 177), and 84% (N=172) of students answered correctly. The comparable quiz problem asks students to determine which polymer that is more likely to crystallize. Over 70% of students received full credit for this problem which is comparable in content and style as parts b, c, and d from the homework.

### 6.3.2 Polymer Structures Exam Analysis

For the final exam, students were asked the following question focusing on polymer structures:

Sketch the expected stress-strain curves for a ceramic and semicrystalline thermoplastic, making sure to label the diagram thoroughly. Explain the different behaviors in terms of the atomic structure.

To analyze student work, the instructor reviewed a sample of 7 students who answered this question 100% correct (15/15 points) and a sample of 7 students who answered the question approximately 50% correct (7.5-6.5 out of 15 points). This approach focuses specifically on high and low achievers. Within these examples of student work, the professor identified several trends in student responses.

Students who answered the question completely correct were able to accurately draw the stress-strain curve and gave detailed explanations of the various aspects of the sketch. They also used the terminology correctly and sometimes made auxiliary sketches to explain the behavior of the materials at various points along the stress strain curve. In all instances for this subset of students, they explained the differences in bonding between the two different materials, even though it was not explicitly required, nor was it necessary to mention for full credit. These responses show that the students understood the underlying physics, how the atomic structure of the materials in question arose, and their impact on mechanical properties.

Of the 31 students who answered this exam question completely correct, 26% of students viewed the polymer structure screencast. This subset of students typically performed very well in the course in that nearly 80% received an A or an A- as their final grade. Further 35% of these students were Chemical Engineers and may have been more familiar with the concepts from previous courses. Further, two-thirds of these students who responded to the end-of-term survey (N=14) did not find the topic of polymer structures difficult. These trends may indicate that these students viewed the screencast less often because they felt confident in their mastery of the material.

Students who received half credit on this problem did not provide any facts that were false, yet managed not to answer the question that was asked. Most of the time, these students drew the stress-strain curve correctly and sometimes described what happens to the material from a macroscopic point of view (eg: "...and will break immediately when it reaches its fracture point.") A few of the students in this subset made a seemingly minor mistake on the drawing, most commonly making the initial elastic regions the same slope for both ceramics and polymers, a glaring mistake as the modulus of elasticity (which is indicated by the initial slope) is many orders of magnitude higher for ceramics than for polymers. These students also stated that the properties of the ceramics and polymers are different, but make no/little attempt to explain these differences in terms of atomic structure even though it is asked for explicitly in the question statement. These responses suggest that these students recalled the general shape of the stress strain curves for these materials, but had only a superficial understanding of the underlying concepts.

Of the 24 students who answered this question approximately half correct, 33% viewed the polymer structure screencast. Only 16% of this subset of students received an A or an A- as their final course grade. Further, 75% of the students in this group consisted of majors outside of Material Science and Chemical Engineering. Interestingly, only a third of these lower achieving students who responded to the end-of-term survey (N=5) found the topic of polymer structures difficult.

Given these observations for the lower achieving students, it seems as though instructor expectations with regards to the mastery of polymer structures does not align with student perceptions. In other words, student *confidence* does not appear to translate into *competence*, especially on a specific topic. This finding presents an interesting challenge for instructors providing supplementary resources because students who need the additional material may not take full advantage. For this exam question, the students who viewed the polymer structures screencast performed slightly better than those who did not by receiving an average score of 11.1 out of 15 points in comparison to 10.4. Realizing that these resources have the potential to clarify unclear concepts for all students, how can an instructor motivate students to use these resources more systematically? This question warrants further study so that all students can receive the maximum benefit from viewing the screencasts.

## 7. Conclusions and Future Work

This study suggests educational promise in the use of screencasts to supplement lecture material in large courses. In particular, using a "muddiest point" technique to assess student confidence levels of course concepts and responding to student misconceptions with a screencast is a promising option for a large lecture survey course. During Fall 2008, when the muddiest point screencasts were aligned with the learning objectives of the course, there was a statistically significant positive correlation for students who viewed the screencast based on the final grade in the course. It is also important to note that students who use screencasts overwhelmingly find the resources useful even if they do not find a topic particularly difficult. Screencasts help reinforce concepts by providing an alternative explanation or additional examples that students can use to study for exams. This study does suggest that further investigation is needed to focus on concepts that particular subsets of students find difficult and addressing student motivation to use these resources. These ideas will be executed in the next iteration of the course.

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