Graphics Course Formative Feedback and Teaching Innovation Using Screen Capture Technology

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Abstract

At most higher education institutions, the promotion and tenure (P&T) process, as well as merit raises, are in part determined by "Teaching Effectiveness," which is primarily measured using student satisfaction survey results. This would typically provide faculty the motivation to improve teaching methods and formative feedback mechanisms for students. Even if an institution does not use student survey results for P&T and/or merit decisions, it is the responsibility of most faculty to practice continuous improvement methods to satisfy program review criteria and/or accreditation agencies, such as the Accreditation Board for Engineering and Technology (ABET) organization, that require an assessment plan.

One method of improving the communication of course materials to the student is by using personal computer technology, which has the capability to efficiently screen capture real-time video and audio. Screen capture technology has made it feasible to provide feedback to students in the form of a movie file that can be downloaded and viewed on the student's own schedule. This process allows students time to review the material outside of class and utilize in-class time for more active learning exercises.

The use of online instruction has become increasingly popular through the years, but for producing most courses, a sophisticated television studio is necessary, requiring much time and staff coordination. This paper describes the desktop computer process used to capture the video for demonstrating NX3 solid modeling graphics software instruction of techniques, and for providing individual feedback on student projects. Obstacles and challenges that must be overcome to develop a system that is not overly burdening to the instructor are described. This paper also discusses some of the feedback from students as a result of the innovations and comparative data from student evaluations of the course taught before and after using these techniques.

Introduction

The step in the formative assessment process where feedback is provided to students to reinforce learning is known as providing formative feedback. Formative assessment used in a typical graphics course involves periodic performance-based tasks (3D models and/or drawings) with feedback to the students concerning strengths and weaknesses. The aim of formative assessment, as described by Gronlund (2006), is to monitor learning progress and

to provide corrective prescriptions to improve learning [1]. Most higher education faculty are evaluated, in part, by administration on their performance using a student rating of instruction (SRI) instrument, where students rate a number of statements using a scale of five to one, "strongly agree" to "strongly disagree," respectively. There are typically several questions on this instrument that are intended to be formative in nature (for the faculty member) and are based on contemporary best practice models derived from higher education research and reflection. There are questions on the SRI related to how well the instructor organizes the course, clearly communicates the course materials, provides awareness of goals, uses class time effectively, and provides timely and constructive feedback on students' work. To fulfill the requirements of a formative and diagnostic assessment system of instruction, the aforementioned best practice characteristics are necessary.

Studies, such as Krautmann and Sander (1999) and McPherson (2006), communicate results that are consistent with the hypothesis that instructors can manipulate better evaluations through more lenient grading [2, 3]. Also, the reliability of the SRI instrument is in question, indicated by results of studies by Li-Ping Tang (1997) and Aleamon and Hexner (2004), where students who were informed that the results of their ratings would be used for administrative decisions rated the course and instructor more favorably on all aspects than students who were informed that the results of their ratings would only be used by the instructor [4, 5]. Regardless of the flaws of the SRI instruments being used for evaluating teacher effectiveness, this tool continues to be used by administration in the promotion process as a major indicator of faculty success. William Glasser (1992) proclaimed that an administrator in a "quality school" must evaluate teaching differently by having teachers critique their own teaching, followed by developing a plan for improvement, and the evaluation should be based on the willingness to participate in this self-evaluation process [6].

One method to provide more formative feedback to students is to interject innovative use of computer technologies, such as integrating online materials that provide students access to course materials outside of class. The major drawback to this idea is that educational experimentation and innovation involve change by definition. Some students welcome change as an effort to improve the class, while others clearly prefer that their instructors "stay within the lines." Some of the most innovative teachers can be effectively excluded from P&T and/or merit raises because these assessments are driven by student evaluation scores, and some students dislike change. The argument is that profoundly re-engineering a course is unlikely to generate the kind of student evaluation scores that are likely to make one eligible for P&T or a merit raise.

What follows is a description of the formative feedback system used in a graphics course re-engineered, utilizing a web-based course delivery system and innovative screen capture technology to record review sessions for students to access outside of class time. The SRI data and qualitative reactions of students will be discussed to determine whether this type of feedback is beneficial to the students and/or the faculty member. Data is provided including SRI scores, student reactions, and student achievement over three semesters of offering the Applications in Parametric Modeling three-credit course.

Applications in Parametric Modeling

The Applications in Parametric Modeling course is offered in the School of Technology (SoT) primarily for Mechanical Engineering Technology (MET) majors. The course was introduced in the SoT using the EDS software, NX3 (Unigraphics), in the fall semester of 2006, after previously using the IDEAS software. The redesign of the course involved not only a change of software, but a change in stressing the importance of modeling using parametric associative techniques to allow design changes to be implemented more efficiently by downstream users. In the first semester, the course was taught using traditional handouts for lab assignments, projects, and exams. In the second semester, the course delivery system WebCT (Blackboard) was added to provide course materials and student submission of assignments via the Internet. The third semester was embellished with the addition of the NX3 software demonstrations provided as screen capture videos with voice narration from the instructor to provide step-by-step procedures for performing modeling techniques.

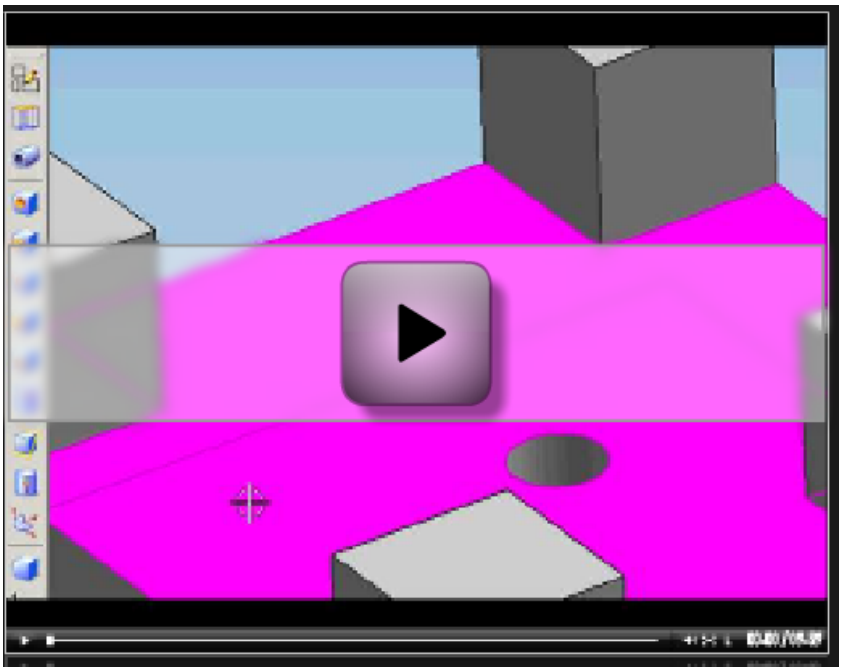

Figure 1: Screen Capture Video Viewer Example

The screen capture technology used was the CamTasia Studio software provided by TechSmith Corporation, which records the screen movements that you are performing on your monitor and the audio from the computer microphone. The video recorded can then be produced to view in WebCT, packaged in a Shockwave video format with a viewer that allows the user to control the play, pause, fast forward, and rewind functions. During this third semester, each student's midterm project model review was recorded and provided as formative feedback to the student with suggestions for improvement. Each video is approximately 15 minutes in length, and there are 30 videos that provide software demonstrations for each of the topics covered in the course.

The Applications in Parametric Modeling class is offered as a three-credit class, which meets two hours per week in recitation and two hours per week in lab. During the recitation, the entire class meets to review the new material, discuss assignments, and complete performance projects. The lab session is limited to approximately 10–15 students, which is usually one-half the size of the recitation. During the lab session, students work independently on modeling assignments, and the instructor is a resource, primarily working one-on-one with students. The recitation and the lab sessions are evaluated separately on the SRI instrument.

Data Collection Methods

During each of the three semesters that this course was offered, it was delivered by the same instructor; and the grading system, assignments, and exams remained mostly unchanged. There have been some changes in the midterm and final project models to deter the possibility of students cheating from one semester to the next, but the assessment criteria has remained the same. The Internet-based instructional delivery system (WebCT) has provided an electronic medium aimed at satisfying the SRI criteria of how well the instructor organizes the course, clearly communicates the course materials, provides awareness of goals, uses class time effectively, and provides timely and constructive feedback on students' work.

For instance, in addition to providing a hardcopy of the syllabus on the first day of the course, the syllabus is posted electronically on the course WebCT page for students to print or view at any time. An electronic calendar tool is included that provides all due dates for labs, quizzes, projects, and exams, which helps with course organization. To address the topic of timely feedback to students, the course WebCT page includes a My Grades section where students can view their grades and comments on all coursework at any time. The Assignment Dropbox allows the instructor to make comments on student assignments and return them for further work before final grading. The Assignment section allows students to upload electronic files for instructor review and, in turn, allows the instructor to attach files for student formative feedback.

The t-test for independent samples is used to check the null hypothesis that there is no significant difference between the two samples of data from the SRI instrument. The t-ratio is evaluated using a non-directional (two-tailed) test at the .05 level of significance. The mean values from the Course Outcome summaries of student achievement are provided for each semester as an indicator if there has been any significant increase in student achievement after implementation of the innovations. The course innovations and formative feedback are not necessarily the only contributing factor in the results because of the various environmental factors impacting the students from the three semesters, including the non-random sample in the study. The t-test for independent samples is used to find the significance of the difference between the means of two samples in the data that revealed the largest difference in means.

The Assessment tool in the WebCT system was used to collect qualitative survey data at the completion of the course in the second and third semester the course was offered. The survey consisted of 10 questions related to how effective the course was in meeting the course objectives and what should be emphasized in the course. In addition to the 20-question SRI instrument provided during the first and second semesters, in the third semester there were 10 questions added to survey students on how effective the screen capture video recordings posted on WebCT were at providing formative feedback.

Results

Keeping in mind the issues related to validity and reliability of the SRI instruments for evaluation of faculty expressed previously, these results may not suggest useful information for making decisions on whether to use new innovative tools for formative feedback. An example of the data that has been collected shows that the rating for the statement, "The instructor made students aware of his/her scheduled office hours," remained unchanged throughout the three semesters. So, even though the addition of WebCT made an electronic version of the information more accessible, it did not make a change in the survey results. The instructional delivery system with all the screen capture videos provided will impact instruction only if the students choose to participate in using the information provided and, in turn, make a thoughtful and unbiased response on the SRI and/or survey questionnaire.

The questions on the SRI that directly relate to the formative feedback and use of the innovative screen capture computer technology, listed below in Table 1 and Table 2, are related to the recitation and lab sessions, respectively. The organization of the course can be impacted through the process of inputting the assignments, assessments, and course material into WebCT format, which in turn communicates this information to the students in a clearer format than hard copy handouts. The goals in the course were provided on the WebCT Course Content page in a Course Outcomes document, as well as on each Activity Plan, which is a detailed list of the tasks to be accomplished for each unit. Feedback is provided immediately after each assessment, assignment, or project is graded by the instructor with comments and/or the video review.

Table 1: Student Rating of Instruction Results – Lecture Sections 2006–08

Question	Fall 2006 n=28	Spring 2007 n=37	Spring 2008 n=27
4) The organization of the course helped me learn.	3.89	4.03	4.00
8) The instructor communicated the course materials clearly.	4.11	3.77	4.00
9) The instructor made students aware of the specific goals of the course.	4.25	3.94	4.37
15) The instructor used class time effectively.	4.18	3.90	4.07
16) The instructor provided timely feedback on my work (homework, assignments, exams, etc.).	4.18	4.03	4.30

Table 2: Student Rating of Instruction Results – Lab Sections 2006–08

Question	Fall 2006 n=10	Fall 2006 n=14	Spring 2007 n=15	Spring 2007 n=10	Spring 2008 n=13
4) The organization of the course helped me learn.	3.90	3.93	3.73	4.00	4.23
8) The instructor communicated the course materials clearly.	4.20	4.21	3.80	4.00	4.07
9) The instructor made students aware of the specific goals of the course.	4.40	4.07	3.67	3.70	4.29
15) The instructor used class time effectively.	4.00	4.21	3.60	4.10	4.54
Combined mean of two lab sections	4.125 (n=24)		3.800 (n=25)		4.54
Standard deviation	1.0		1.1		1.0
t-test results – Fall 2006 to Spring 2007	t = 1.10, df = 47, p = .2779 > .05				
t-test results – Spring 2007 to Spring 2008	t = –2.84, df = 36, p = .0073 < .05				
t-test results – Fall 2006 to Spring 2008	t = -1.66, df = 35, p = .1049 > .05				
16) The instructor provided timely feedback on my work (homework, assignments, exams, etc.).	3.80	4.36	3.87	4.20	4.31

In 60 percent of the SRI statements shown above, there was an increase in the rating over the three semesters. The largest difference from the first to the last semester rating was in the lab session for statement 15, “The instructor used class time wisely,” which was a difference of .54 points. This statement also showed the largest overall difference between the lowest to highest rating, which was .94 points. The t-test value of –2.84 indicates that the null hypothesis should be rejected for the comparison of the data from Spring 2007 and Spring 2008 in question 15. Therefore, there is a significant difference in the scores from these two groups. The least impacted rating was the recitation session statement 4, “The organization of the course helped me learn,” which was a .14 increase from the first to second semester. The statements that were rated lower from the first to third semester are shown highlighted in the table. It is interesting to note that each of these highlighted statements was rated higher from the second semester to the third semester offering.

The survey questions asked at the end of the semester during the second and third semester course offerings mostly remained constant for the effectiveness of meeting the course objectives. The two areas of notable improvement were 4 percent in the excellent ratings in “Improving skills in sketching, 2D curve creation techniques” and “Creating motion analysis of assemblies.”

Table 3 – The Effectiveness of Meeting Course Objectives Survey Results

Survey Question	Poor		Below Average		Average		Above Average		Excellent	
(2007 n = 39 & 2008 n = 32)	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Improving skills in sketching, 2D curve creation techniques			3%		31%	37%	51%	44%	15%	19%
Improving 3D solid and surface modeling techniques					5%	15%	51%	47%	44%	38%
Improving 2D layout drafting/dimensioning techniques			5%		15%	34%	49%	41%	31%	25%
Improving ability to perform assembly modeling, constraining, and drafting of assemblies			3%		18%	28%	49%	47%	30%	25%
Creating motion analysis of assemblies	3%	5%	8%	9%	46%	34%	28%	31%	15%	19%
Utilizing geometric dimensioning and tolerancing techniques			15%	28%	49%	31%	26%	38%	10%	3%
Solving 3D spatial relationship design layout solutions		3%	9%	3%	44%	50%	41%	38%	6%	6%

For continuous improvement, faculty members are required to conduct individual course assessments at the end of each semester. This data is used to make adjustments and improve the students' learning experience. The course improvements are summarized each year in a Summary of Program Improvements document. The achievement standard is that 70 percent of the students perform at a level of 70 percent or better for each of the course competencies, which are linked to the program outcomes (ABET C3 a-k C9 A-C). Examples of assessment methods used are: assignments, labs, exams, quizzes, and performance projects. In Table 4, there are results from the three semesters that the Applications in Parametric Modeling course has been offered. Recommendations for course-level improvements are made each semester using these results, along with other input such as senior exit surveys, certification exams, and senior project evaluation. This table indicates the percentage of students who achieved 70 percent or better in each of the categories.

Table 4 – Summary of Course Outcomes Results for Parametric Modeling 2006–08

Semester	Exams	Performance Assessment	Quizzes	Labs
Fall 2006	83%	83%	84%	83%
Spring 2007	69%	97%	87%	87%
Spring 2008	88%	82%	73%	100%

The largest improvement from the first to third semester of this course is in the area of lab performance, which yielded a 17 percent increase. There was a 14 percent drop in the quiz category from the second to third semester. Most of the remaining categories fluctuated up and down but did not change significantly from the first to third semester.

Finally, in Spring 2008, students were asked 10 additional questions on the SRI instrument related to the screen capture videos. Five questions rated the course instruction in areas on a scale of "Excellent" to "Poor," and the remaining five questions were answered "yes," "no," or "no opinion." Table 5 and Table 6 relate the data from this qualitative survey of student perspectives of the course. The first table indicates that the majority of students rated the videos as either "Above Average" or "Excellent" in each of the question topics. The highest rating was for the usefulness of the play/rewind functions.

Table 5 – The Rating of Instruction Using Screen Capture Videos – Percentages (n=26)

Question	Poor	Below Average	Average	Above Average	Excellent
Screen capture video recording content		3.7	11.1	51.9	29.6
Screen capture video recording sound and visual quality		7.4	22.2	51.9	14.8
Screen capture video recording usefulness as an instructional aid to learning		3.7	11.1	37	44.4
Screen capture video recording critique of midterm modeling project usefulness as an instructional feedback mechanism	3.7	0	14.8	55.6	22.2
Screen capture video usefulness of the "play/rewind" functions			7.4	22.2	66.7

For each of the questions in the next table, the majority of students answered "yes" to each topic. The question that was answered highest by approximately 89 percent of the students was that screen capture videos should continue to be used. The question answered "yes" the least was that approximately 41 percent believed that the assessment quizzes provided motivation to review the chapter information prior to recitation sessions.

Table 6 – The Rating of Instruction Using Screen Capture Videos – Percentages (n=26)

Questions	Yes	No	No opinion
Should the class continue to utilize screen capture video component in WebCT as an instructional tool for software demonstration?	88.9	3.7	3.7
Should the class continue to utilize screen capture video component in WebCT as a feedback mechanism for student projects?	66.7	11.1	18.5
Did the WebCT assessment quizzes provide motivation to review the chapter information before class lectures?	40.7	37	14.8
Did the lab assignments prepare you adequately for the midterm course project?	66.7	14.8	18.5
Do you feel that this course material has prepared you for using NX3 for your coursework?	81.5	11.1	3.7

Discussion

In addition to the reliability and validity factors discussed earlier, the first semester ratings may indicate that the course was rated higher due to outside factors, such as the course and instructor were new to the SoT. Generally, the SRI ratings were better after the addition of the WebCT, and the largest increases were from the second to third semesters when the video capture technology was used for formative feedback. The fact that the largest increase was the rating of the instructor using class time wisely is a direct result of not having to demonstrate the software techniques repeatedly during class. The screen capture images are available at any time for students to play and replay until they master the technique, instead of using valuable class time.

The rating of the effectiveness of the course meeting the course objectives was generally the same between the two semesters. The WebCT was offered as a course tool for both semesters, with the only difference being the screen capture videos. The two topics, "Improving skills in sketching, 2D curve creation techniques" and "Creating motion analysis of assemblies" are areas that students seem to have the most difficulty in during the course. The ability to constrain a sketch properly and the ability to create joints in a motion scenario are two techniques that usually rely on extra one-on-one time with students in lab for them to grasp the concepts. Adding the screen capture videos in the course may have offered students

another option to master the material, rather than solely relying on the one-on-one instruction in lab.

The Summary of Course Outcomes indicates that students increased success in the area of performing labs at a 70 percent or better level in the course. This can be attributed to many factors, including the variable that students in the course may have had an increased prior knowledge of the software from prerequisite courses over the previous years because the new NX3 software had just been introduced in the SoT. Although, the screen capture videos may have contributed to the student success because they would be able to review the material after receiving feedback on their first submission of the assignment with comments and then follow-up with the appropriate corrections. Students in previous semesters relied on the comments and then had to their notes and the textbook to make corrections to their lab projects. Many students during the first two semesters did not make the corrections to the labs and, therefore, received the initial grade assigned.

The qualitative analysis of the 10 additional SRI survey questions indicates that students are satisfied with the screen capture video technology innovation used in this course. Although there still is room for improvement in the area of screen capture video content and quality, the majority of students are in favor of the continued use of this technology that they believe helps to prepare them to use NX3 software for their future coursework.

Conclusion

The time investment to create a 15-minute screen capture video is close to one hour if you use the same type of video producing software and computer hardware utilized in this study. The screen capture video review of each of the student's midterm projects is, therefore, a large project for the faculty member with little quantitative benefit in terms of student performance. Furthermore, there is not a substantial rise in SRI instrument ratings used for P&T and/or merit raises. The majority of students views the use of this technology as necessary for their learning but may not be appreciative of the amount of effort that is necessary to create this formative feedback.

The main advantage to creating the screen capture video content is that with additional course material, such as a webcam video of recitation/lectures, the course can be administered as an online offering. Also, as with most course materials, the creation of the content is very time intensive at the beginning, but once the screen captures are created, they can be reused with minor updates for future semesters. The graphics software may have periodic new releases that will require re-recording or editing some of the demonstrations. The advantage of personally recording these rather than using software training videos is that the faculty member can customize the recordings pertaining to the specific course outcomes.

The use of screen capture video in this graphics course has allowed for the recitation and lab sessions to be used for more active learning activities, where students are interacting with the faculty member and allowing for time to receive and give feedback concerning course projects. If this technology is to be integrated into a graphics course, it is important that the

video is embedded with a video player that has the play/fast forward/rewind function. Students want to be able to easily navigate the video to the point that they need more information, and then pause to toggle back to the software application to try out their techniques.

From the perspective of improving scores on SRI instruments for P&T decisions and merit raises, even an increase of as little as .05 points on a five-point scale can get to that magic threshold that the administration is looking for on their evaluation rubric. In this case study, there was not a significant negative impact from implementing the formative feedback screen capture technologies. So in this case, the change was welcomed by students as necessary and beneficial to improve teaching and learning.

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Biography

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