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Using Peer-Generated Screencasts in Teaching Computer-Aided Design

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Using Peer-Generated Screencast in Teaching Computer-Aided Design

Abstract

This paper presents a new method of using peer-generated screencast in the computer-aided design (CAD) education. Instead of using instructor-made screencasts, students were asked to make their own screencasts, review each others' screencasts, and provide feedback. To explore the impact of student-made screencast exercises on students' learning outcomes, we conducted a pretest posttest quasi-experimental research. A life-long learning survey, an engineering attitude survey, an exit project survey, and a CAD modeling exam were used as the study instruments. Among the students enrolled in six different sections of a CAD course, 110 of them completed all research instruments and participated in the study. This is a continuing research project, sponsored by the National Science Foundation, starting from Fall 2014. In Fall 2014 and Spring 2015, students in the experimental groups completed one screencast exercise after completing a trial exercise. Findings indicated that the students would like completing more than one exercise. Therefore in the second year, we asked the students in the experimental groups to complete more than one screencast exercise in addition to completing the trial exercise. Findings from the past two years indicated that the students in the experimental groups performed better than those in the control groups in the CAD modeling final exam.

Introduction

Screencast is an effective learning tool for CAD education, in which popular CAD software, such as NX, Pro/E, and Solidworks are taught to prepare students for their future careers[1]. In the screencast, the procedural operations of making three-dimensional (3D) models are presented visually along with the audio narration[2]. The literature shows that screencasts have been used in recent years as educational tools to teach a wide variety of topics, such as statistical methods[3], engineering education[4-7], and nursing[8]. The versatility of a screencast makes it a powerful addition to in-class teaching, often supplementing and reinforcing the learning materials. Researchers have reported that the screencast is an effective learning tool to aid in a classroom environment[9-11].

Traditionally, the instructors make the screencasts and use them in their in-class teaching or provide them to their students as supplementary aids. Students review the screencasts to learn about the procedures. In this learning process, the students are kept in a passive role. They only follow the directions provided in the screencast. Their metacognition and creativity will not be triggered or activated by reviewing the teacher-made screencasts. Teacher-made screencasts lead the students to rote-memorize the presented steps and copy them to the application environment without meaningfully understanding the tasks[12]. Teacher-made screencasts may distract users from concentrating on key issues[13]. The learners perceive the screencast as an easy way of learning. This enforces a less active and less engaged role and it undermines the learning outcomes[14]. Teaching through the instructor-made screencasts is a knowledge-centered and teacher-oriented[15] pedagogy that does not promote the desired student learning objectives.

In our project, we have assigned students an active role in developing and utilizing the screencasts[18]. We have asked the students to create the screencasts, record the supported audio, post them on the electronic repository, and take the leadership of organizing the peer-to-peer learning process. It has been our hypothesis that allowing students to create the screencasts and share them with their peers will improve the students' CAD knowledge and help them develop life-long learning skills. When students actively participate in creating the screencasts, they will feel more empowered about the knowledge that they are learning. Such learning environment is considered student-centered and learner-oriented[15]. Student-centered learning environments are more preferred than teacher-centered learning environments as discussed by Bransford et al. in their mostly cited essay "How People Learn"[15]. Literature has shown that students' content learning, motivation, and interest develop more effectively when they learn in student-centered and learner-oriented environments[15,16]. Students become more involved and engaged when they take the responsibility of a task that involves creativity and metacogition. As students make screencasts, they have to use their metacognitive skills. They need to consider the learner's perspective and provide directions and explanations that best explain the procedures. As they talk aloud about the procedures that they show or explain, they re-address their own thinking and examine if their thinking is well presented and communicated. As the students recognize the gaps in their thinking, they will be more willing to reach out to learn more about the topic. It is likely that they visit with their instructor or teaching assistants to get some help or aid, or reach out to peers or others who may help them to check their thinking.

As students review each other's screencasts, their own thinking and metacognition will be re-evaluated from another learner's perspective who is not necessarily a teacher or a textbook author. Learning from peers is more authentic and more sustainable than learning from a textbook or from a teacher[17]. In addition, receiving peers' comments on their own screencast adds to these metacognitive items that will eventually help improve their CAD knowledge and skills.

In this National Science Foundation (NSF) project, two mechanical engineering faculty and two learning scientists have collaborated to implement a student-centered instructional strategy, namely peer-generated screencast strategy in teaching CAD in the undergraduate level. For this purpose, we grouped the students into two groups: control group and experimental group. Students in the control group received the traditional teaching. The screencast tutorials they reviewed were teacher-made. Students in the experimental groups generated the screencast tutorials in groups. They audio-recorded their own explanations about the procedures. The students shared their screencast tutorials with their peers in a mutual-learning environment. They viewed the peer-generated screencasts online and provided feedback. The students reviewed the feedback generated by their peers about their own screencast tutorial.

Study Design

In order to evaluate the effects of the peer-generated screencast tutorials on students' learning outcomes, we have conducted a pretest-posttest quasi-experimental research. Since Fall 2014, we have administered pre- and post- surveys at the beginning and at the end of each semester. Our pre and post research instruments captured the changes in students' attitudes towards engineering and their life-long learning skills. A CAD modeling exam has been given at the end of each semester to evaluate the students' learning of the CAD modeling skills. The CAD modeling exam, life-long learning survey, and engineering attitude survey generated quantitative data. We analyzed the quantitative data using the statistical tests. Students in the experimental groups completed an exit survey that explored their lived experiences with the screencast-making activities. Selected students in the experimental groups were interviewed by the researches. The exit survey and the interview data generated qualitative data. We analyzed the qualitative data using the constant comparative method. Up to date, we have collected data from 110 undergraduate students, with 60 students in the control groups and 50 students in the experimental groups. All 110 participants completed all research instruments that belonged to their group and signed the consent forms.

Our first year's findings[18] indicated that students would have liked to design the screencast tutorials more than once in order to learn about the process, resolve the technical challenges, and design more qualified screencast tutorials in the coming semesters. In Fall 2015, students in the experimental groups completed the screencast exercises more than once.

Study Context

The project was implemented in a freshman "Mechanical Engineering Drawing" course that was offered in Mechanical Engineering Department. The course has been designed to teach students CAD modeling skills using Siemens NX and prepare them for their future career in design and manufacturing. Students and instructors met for three hours every week for this course. The present project was launched in Fall 2014 and it has been implemented since then (i.e., Fall 2014, Spring 2015, and Fall 2015). Students in the control groups received the traditional instruction where the instructor made the screencast tutorials. Students in the experimental groups were asked to make the screencast tutorials by their own. They were offered the modeling software, NX, and the screen recording software, Techsmith Snagit. Snagit supports long-time video capturing with MPEG-4 video format. MPEG-4 video format is compatible with many devices, including PCs, tablets, and smart phones[19]. By using NX and Snagit, CAD modeling procedures on a computer screen plus the audio narration could be recorded as a screencast. Meanwhile, an online forum named "Ecourses," offered by the University's distance learning department, was used for the students in the experimental groups to share their screencast with their peers and collect feedback and comments from other students. All student-made screencasts and comments were managed and maintained by the instructors. When the student-made screencasts were well designed and approved by the peers, the instructors collected them in a database. Otherwise the screencasts were assigned back to the students. The process of database management and retaining the student-made screencast tutorials is illustrated in Fig. 1.

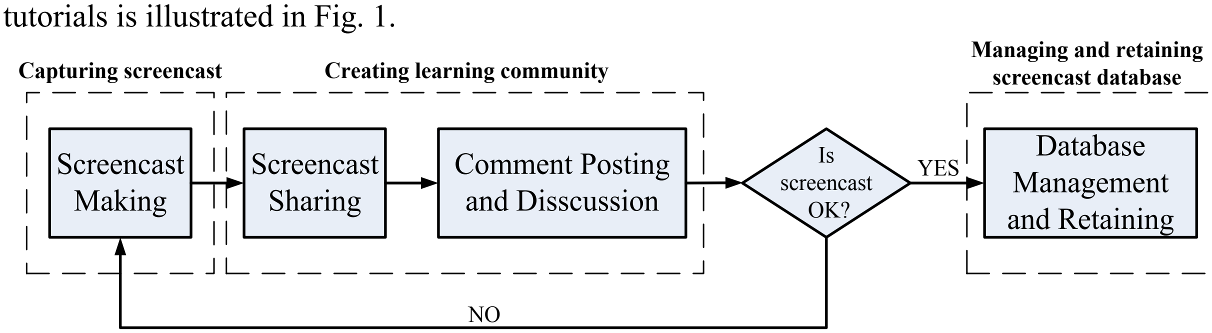

Fig.1 The process of database management and retaining

The students in the experimental groups were divided into small teams with four to six students in each team. Screencast homework was given to students and all project activities were conducted in teams. Each student in a team was assigned with a tag A or B: "tag A" for generating a screencast and "tag B" for providing comments. Students with different tags took one of the two following roles: either making the screencasts or providing comments. Screencast exercises were designed to promote self-learning of the CAD modeling skills. Each team was asked to create and maintain a complex geometry-based modeling screencast library on the course website in each semester. Students were assigned individual homework to model relatively complicated objects, which required them to apply the combination of more than two features that they learned in class and also to self-learn new features which were not covered in class. For example, the objects shown in Fig. 2 could be modeled using such features as block, cylinder, cone, hole, and pocket, some of which were not taught in class. In the experimental groups, each study team created the screencast tutorials including the screen captures of the modeling processes of the complicated objects and audio narrations explaining the procedures. All student-made screencasts were also subject to peer review. Students submitted each screencast to the Ecourses, where other members of their team watched and then gave constructive feedback. Each screencast coincided with that week's learning objective, usually pushing the student's limit, and challenging them to think outside the box.

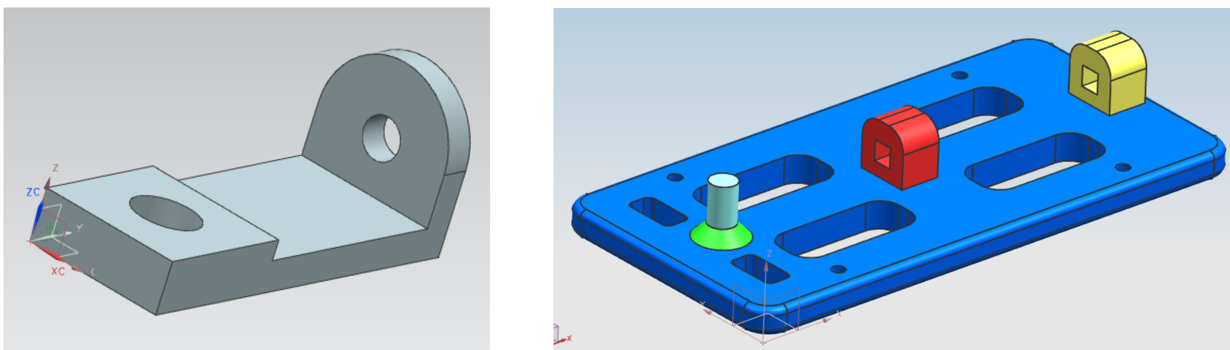

Fig.2 Screencast exercise objects

Study Instruments

In order to evaluate the outcomes of the project activities, five study instruments were employed: a demographic questionnaire, a life-long learning survey, an engineering attitude survey, an exit project survey, and a CAD modeling skill, as discussed below:

Demographic Questionnaire: The brief demographic questionnaire was designed to collect the information on students' gender, ethnicity, age, major, and first generation college student status.

Life-long Learning (LLL) Survey: The LLL survey was designed by Wielkiewicz & Sinner[20] in order to evaluate the respondents' life-long learning skills. Project activities required the students to learn some of the technical knowledge outside of the class activities. The course instructor and the teaching assistants were available to meet with the students outside of class. Students had access to the textbooks, the Internet, and the various sites about the technical aspects of the modeling procedures. We have anticipated that students' life-long learning skills would improve because of the activities they completed as they made their screencast tutorials. Furthermore, students reviewed each other's screencast tutorials and provided comments. Students had the opportunities to learn from each other's screencasts. This aspect of the project might have promoted the belief that students could continue learning about the new software by reviewing peers' screencast tutorials. The LLL survey was administered in both experimental and control groups at the beginning and the end of each semester. The gain scores were computed and compared across the experimental and control groups.

Engineering Attitude Survey (EAS): The EAS was designed by Robinson et al.[21] to explore the students' attitudes towards engineering. In our project, we have assumed that the screencast-making activity would help increase students' attitudes towards engineering because of its student-centered and learner-oriented characteristics. We have also anticipated that the collaboration among the team members would help students realize the importance of the team-work and information sharing in engineering. In the screencast exercises, the students made the efforts to provide clear and instructive video tutorials, which might have helped them understand the importance of the oral communication and presentation skills in engineering besides the problem-solving skills. The EAS was administered in both experimental and control groups at the beginning and the end of each semester. Similar to the LLL survey, we computed the gain scores and compared them across the experimental and control groups.

Exit Project Survey: The exit project survey was designed to explore students' experiences with the screencast activities in the experimental groups. The survey included closed-ended and open-ended questions. It generated both quantitative and qualitative data about the students' experiences. We administered the exit project survey at the end of the semester only in the experimental groups. Because the students in the control groups did not have any screencast-making experience, they did not complete the exit project survey. The survey responses were used to evaluate the project activities and advance the research design in the upcoming semesters.

CAD modeling exam: A CAD modeling exam was designed to capture students' CAD knowledge and their modeling skills. The exam was administered in both control and experimental groups at the end of the semester. The students' final exam grades were compared across the control and experimental groups in order to evaluate the effect of the project activities on students' CAD knowledge and modeling skills.

Results and Discussion

Fall 2015 semester was the second year that we implemented the project activities. In 2014-2015 academic year (i.e., Fall 2014 and Spring 2015), the results of the data collected were reported elsewhere[18]. In this paper, we report the data collected over the past three semesters or between Fall 2014 and Fall 2015.

Up to date, 110 students participated in this study. The data collected in the control groups were collected from one section in Fall 2014, one section in Spring 2015 and one section in Fall 2015. The data collected in the experimental groups were collected from two sections in Fall 2014 and one section in Fall 2015. In Fall 2014, all students in the experimental groups were divided into nine teams with six students in each team. There were a total of three screencast exercises assigned to the students. The first screencast exercise was given to every student as a trial. They completed the first screencast exercise in order to be familiar with the Snagit software and Ecourses platform. After completing the first and trial screencast exercises, half of the students completed the second screencast exercise and the other half reviewed the peer-generated screencasts and provided comments. Next the student groups switched and one half of the students completed the third screencast exercise and the other half reviewed these screencasts and provided comments. At the end of the semester, each student completed one trial and one actual exercise.

As discussed in Zhang et al.[18], the students who completed the screencast exercises strongly recommended to run the same exercise not once but more than once after the initial trial exercise. By doing so, students could focus more on the actual objectives of the activities instead of trying to fix the technical aspects of the activity, for example, recording the audio or playing the video. In other words, students wanted to complete the same screencast exercises multiple times so that in the second and third trials they would be more comfortable in recording the screencasts and their audio narrative and be able to focus on their metacognition regarding the content of their screencast.

In Fall 2015, we employed the same activity more than once over the semester. There were four teams and six screencast exercises assigned to the students. The first exercise was for trial. It was designed for each student to practice using the Snagit software and Ecourses platform. In the second, third and forth screencast exercises, students with tags "A" and "B" took turns to make screencasts and give feedback. In the fifth screencast exercise, all students made screencast and provided feedback at the same time.

A total of 110 students completed all research instruments as of today. Among these 110 students, 77% of them were male and 23% of them were female students. In the experimental groups, 74% of the students were male and 26% of them were female students. In the control groups, 80% of the students were male and 20% of them were female students. Table 1 summarizes the participants' gender across the treatment groups.

Table 1. Participants' Gender Across the Treatment Groups

	Experimental Groups	Control Groups	Total
Male Students	37 (74%)	48 (20%)	85 (77%)
Female Students	13 (24%)	12 (80%)	25 (23%)
Total	50	60	110

Thirty-five percent of the participants were first-generation-college students and 72% of them were not first-generation-college students. In the experimental groups, 34% of the students were first-generation-college students and 66% of them were not first-generation-college students. In the control groups, 35 % of the students were first-generation-college students and 65% of them were not first-generation-college students. Table 2 summarizes the participants' first-generation-college student status across the treatment groups.

Table 2. Participants' First-Generation-College Student Status Across the Treatment Groups

	Experimental Groups	Control Groups	Total
First-Generation-College Student	17 (34%)	21 (35%)	38 (35%)
Not First-Generation-College student	33 (66%)	39 (65%)	72 (65%)
Total	50	60	110

Around 73% of the participants were African American, 9% of them were Latino/Hispanic, 5% of them were Asian, and 1% of them were Caucasian. Four percent of the participants reported that they have mixed ethnicities and 11% of them reported that they have ethnicities that were not listed in the questionnaire. Table 3 summarizes the participants' ethnicities across the treatment groups. In Table 4, the number of students in each treatment group is reported.

Table 3. Participants' Ethnicities Across the Treatment Groups

	Experimental Groups	Control Groups	Total
African American	38	42	80 (73%)
Latino/Hispanic	4	5	9 (8%)
Asian	2	3	5 (5%)
Caucasian	1	1	1 (1%)
Mixed	2	2	4 (4%)
Other	3	7	11 (10%)
Total	50	60	110

Table 4. Number of students participated in the treatment groups

	Fall 2014	Spring 2015	Fall 2015	Total
Control Groups	17	23	20	60
Experimental Groups	19+21	-	10	50
Total	47	23	30	110

In Fall 2014, two sections received the treatment and one section received the traditional instruction. In Spring 2015, only one section received the traditional instruction. In Fall 2015, one section received the treatment and the other section received the traditional instruction. The results are shown as below:

Screencasts and comments

In the screencast homework, students used different modeling skills to create their models. An example of the screencast exercises is illustrated in Fig 3. In this exercise, there are multiple ways to create the model. Most students learned new tips and shortcuts in this exercise, for example, using circles and constraints, or using reference lines to draw each object. Over each semester, the quality of the student-generated screencasts had been dramatically improved. As students reported, they were more confident of making screencasts towards the end of the semester than how they felt in the beginning.

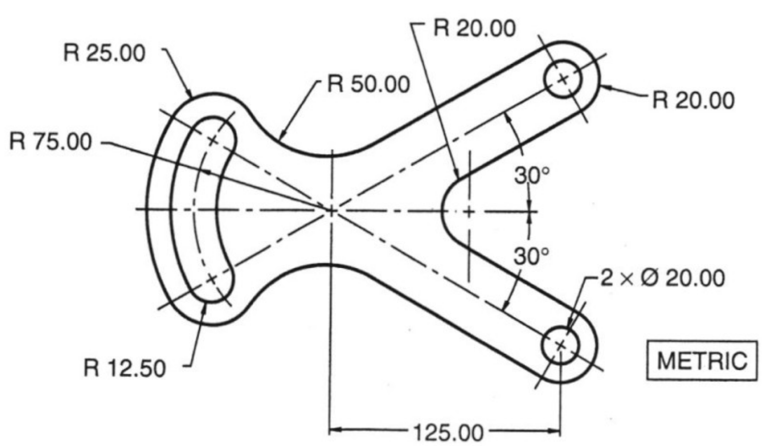

Fig.3 One example of screencast exercises

Students commented on their peers' sceencasts after reviewing them. They posted their comments online. Early in the semester, students had provided simple and superficial comments. After getting some screencast-making experiences over the semester, the students began providing detailed and thoughtful comments. For example, early in the semester, a student commented as: "*I felt like they did a good job. I just think they should go more in detail, if they could explain better.*" After the mid of the semester, another student comment was quite detailed and constructive as illustrated below:

"After watching the video, I found it very simple to use your steps to create the object. Being familiar with the toolbar, you made it clear to the audience exactly how to reach the thread bar by using the command tool. Also the video was very precise and accurate to what you were lecturing throughout the process. Another interesting factor in the video is that the base diameter, top, and height were already preset which made an even smoother process. Overall you kept the video short, brief and very detailed, which made it easy to understand."

In the second and third screencast tutorials that students had generated, they were more able to express and highlight the important procedures. In the initial exercises, they did not effectively point out the key characteristics of their procedures. For example, students repeated the key modeling procedures more than once in their succeeding screencasts tutorials in order to help readers follow the procedures easily.

Life-long learning (LLL) survey and engineering attitude (EA) survey results

Hundred-ten (110) students participated in the project activities between Fall 2014 and Fall 2015 in the control or experimental groups and responded to all research instruments. All student participants responded to a demographic questionnaire that asked them to indicate their ethnicity, sex, major, and whether or not they were first-generation-college students in their family. Students completed the LLL and EA surveys twice: once at the beginning of the semester and the other at the end of the semester. LLL survey included 16 Likert-scale items on a 5-point scale (Always or daily =5, Often =4, Sometimes = 3, Rarely =2, Never = 1). EA survey included 25 Likert-scale items on a 6-point scale (Very strongly agree =6, Strongly Agree =5, Agree =4, Disagree =3, Strongly Disagree =2, Very Strongly Disagree =1). The mean values of the students' responses to the items in both surveys were computed. Next, each student's gain scores were computed in both surveys (Gain LLL score =Post LLL score – Pre LLL score and Gain EA score = Post EA score – Pre EA score). The mean scores and their standard deviations are represented in Table 5 and Table 6.

Table 5.The mean scores of the students' responses to the LLL scale

	Number of Students	Pre LLL score means (SD)	Post LLL score means (SD)	Gain score for the LLL scale (SD)
Control Groups	60 (12 female)	3.67 (0.51)	3.76 (0.61)	0.08 (0.05)
Experimental Groups	50 (13 female)	3.54 (0.51)	3.57 (0.60)	0.03 (0.05)

When we analyzed the pre, post, and gain scores for the control and experimental groups, no statistically significant difference was observed. When we compared the pre-LLL scores and post-LLL scores for each group separately by running two independent *t*-tests, no difference was observed. In other words, control group students' pre-LLL scale responses (M_{Cnt} =3.67) did not statistically significantly improve in the post-LLL scale (M_{Cnt} =3.76) (t (59)=1.82, p=0.07).

Similarly, experimental group students' pre-LLL scale responses (M_{Exp} =3.54) did not statistically significantly improve in the post-LLL scale (M_{Exp} =3.57) (t (49)=0.61, p=0.54).

Table 6.The mean scores of the students' responses to the engineering attitude (EA) survey

	Number of Students	Pre EA score means (SD)	Post EA score means (SD)	Gain score for the EA survey (SD)
Control Group	60	4.40 (0.51)	4.31 (0.66)	- 0.09 (0.66)
Experimental Group	50	4.28 (0.52)	4.30 (0.60)	0.02 (0.40)

None of the means in Table 6 were statistically significantly different from each other. Control group students' post-EA scores (M_{Cnt}=4.31) were not significantly different from their pre-EA scores (M_{Cnt}=4.40) (t (59) = -1.01, p =.031). Similarly, experimental group students' post-EA scores (M_{Exp}=4.30) were not significantly different from their pre-EA scores (M_{Exp} = 4.28) (t (49) = 0.33, p=0.73).

Findings indicate that students' attitudes towards engineering as captured by the EA survey and their life-long learning skills as captured by the LLL scale were not significantly improved because of the project activities. This finding was not aligned with our expectations. We will continue re-iterating our design and collect more data. Individual and group interviews with the students will be conducted to explore the students' experiences with the Fall 2016 project implementations.

CAD Modeling Exam

Table 7 represents the mean scores of the students' final exam for each group. The mean of all students' final exam scores was 73.52 that was out of 100 and with a standard deviation of 21.89.

Table 7. Students' final exam means across the treatment groups

Treatment Type	# of Students	Final Exam Means	Std Dev
Control Group	60	69.38*	24.98
Experimental Group	50	78.50*	18.22
Total:	110	73.52	21.89

*p<0.05

When we compared the mean scores of the students in the control and experimental groups (n_{Cnt}=60, n_{Exp}=50), we found a statistically significant difference at the $p<0.05$ level (M_{Cnt}=69.38, SD_{Cnt}=24.98; M_{Exp}=78.50, SD_{Exp}=18.22, (F (1, 109)=4,61, p=0.03). This indicated that students who received the treatment performed better than the students who did not receive the treatment in the final exam.

When we analyzed students' final exam scores with respect to their ethnicities and gender and across the different type of treatments, no statistically difference was found between the groups. When we analyzed the final scores with respect to students' first-generation-college student status across the treatments, we found a statistically significant difference at the $p<0.05$ level in the experimental group students. In the experimental groups, students who were first-generation-college students did significantly better than their peers who were not first-generation-college students. ($n_{FirstGeneration}$ =17, $M_{FirstGeneration}$=85.88, $SD_{FirstGeneration}$ = 4.26; $n_{NotfirstGeneration}$ = 33, $M_{NotfirstGeneration}$=74.69, $SD_{NotfirstGeneration}$=3.06, (F (1,49) = 4.53, p = 0.03).

When we analyzed students' final exam scores, their pre, post, and gain scores from the LLL survey and the EA survey across the two different types of experimental groups, we did not find any statistical difference. In other words, increasing the frequency of the exercises did not necessarily generate better results. One reason that we didn't observe a positive difference is because in the experimental group of Fall 2015, the number of qualified participants was very low (only 10 students). We will continue collecting data from the experimental groups where the students complete the screencast exercise several times and then run the same analyses to see if any statistical significance difference will be observed.

Project Exit Survey

In order to collect the feedback from students in the experimental groups and improve the quality of the future project activities, students in the experimental groups were asked 13 questions. Question 2 through 8 included the answers as 'a lot,' 'a little,' and 'not at all.' Those eight questions addressed the students' evaluation of the screencast exercises. The summary of students' responses to questions 2 through 8 were tabulated in Table 8. Most of the participants who installed NX in their personal computers mentioned that it improved their learning 'a lot.' Besides, the results of questions 3 and 4 indicated that screencast exercises improved their learning of NX software and engineering drawing and modeling. While exploring the help of reading and commenting on each other's screencast videos with questions 5 and 6, the results indicated that most students found it useful to learn modeling techniques by making and reading comments. When participants were asked about the easiness of Ecourses platform, a high percentage of them found it easy to use. Finally, the effectiveness of Ecourses platform for students' learning in CAD was rated mostly as 'a little' followed by 'a lot.'

Table 8. Students' responses to Questions 2 through 8 in the project exit survey

Questions	A lot (%)	A little (%)	Not at all (%)
Did installing NX on your computer improve your learning?	62.50	31.25	6.25
Did the screencast exercises help you learn the NX software?	43.18	45.45	11.36
Did the screencast exercises help you learn the engineering drawing and modeling?	39.53	53.49	6.98
Did commenting to others' screencast videos help your learning of modeling techniques?	22.73	47.73	29.55
Did reading your group members' comments on your screencast videos help your learning of modeling techniques?	40.91	43.18	15.91
Was the Ecourses platform easy to use?	65.91	29.55	4.55
Was the Ecourses platform effective for your learning in CAD?	29.55	59.09	11.36

Questions 9 through 13 in the exit survey were open-ended questions for the students to express their lived experiences with the screencast exercises. In their answers, students elaborated on what they liked and learned in the screencast exercises. In addition, the challenges they had during those exercises and their recommendations to improve the screencast exercises were also asked. One of the most frequent responses given by the participants was how they liked and learned to do "different ways" for the screencast exercises. They reported that they liked working with their peers because it made it "easier for them to understand the exercises." They experienced technical difficulties while using the microphone or hearing their voice. In their second and succeeding screencast generation activities, they were able to overcome most of the technical challenges. In general, students' experiences with the screencast generation activities were positive. The experimental group students who completed the exit survey questions liked and learned through the screencast exercises. The last question of the exit survey asked for students' recommendations to improve the screencast exercises for future students. The most common recommendations reported for the improvement of the exercises for the future students were (*a*) having better equipment to solve the audio problems and (*b*) providing more opportunities to practice the screencast exercises.

Conclusion and Future Work

In this paper, we reported our findings from an NSF funded project that is still ongoing. Two engineering faculty, two learning scientists, and students in engineering and education were the project team members. In our project we have used the screencasts in undergraduate CAD education differently from its traditional use. Instead of providing the students with the teacher-made screencasts, we asked the students to make their own screencasts, share them with their peers, review each other's screencasts, provide comments, and read their peers' comments to their original screencasts. As students generated the screencast exercises, they audio-recorded their own explanations about the procedures that the tutorials entailed. These explanations triggered students' meta-cognition. Generating a screencast tutorial from scratch required creativity. Students' metacognition and creativity were activated in the screencast tutorial activities. In return, our students were empowered and more engaged in the material that they were learning. This learning environment is student-centered. The students also worked in teams and completed reviews of each other's screencasts that made their learning activity community centered. Reviewing each other's screencast and providing comments also helped students socially engage in what they were learning about and might have shown to them that they could continue learning from their peers even after graduation. This aspect of the project activities has been related to the students' lifelong learning skills. Learning the CAD procedures from their peers and their active and empowered engagement in the material that they learned might have improved their attitudes towards their engineering. As mentioned earlier, we have anticipated improving students' engineering attitudes, life-long learning skills, and their CAD modeling skills by implementing this novel way of using the screencast exercises. Our findings indicated that students' CAD modeling skills had been improved because of their participation in the project activities. Our findings did not show significant improvement on the students' attitudes toward engineering or their life-long learning skills. We will continue to iterate the design efforts. We will re-evaluate and re-design the project activities in order to help our students improve their life-long learning skills and engineering attitudes in the upcoming semesters.

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