LEARNING THROUGH STUDENT GENERATED VIDEOS IN A FLUID MECHANICS COURSE

Student Paper

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Abstract

This paper discusses a two year study on the effectiveness of learning concepts in an introductory fluid dynamics course, by teaching through video. The intention of this activity was to take a concept the professor discussed during class, and articulate it in video media using everyday examples that other students can relate to. The goals were to 1) generate a scenario where students can better learn course material by requiring them to teach their peers, and 2) create a repository of videos that can be used in subsequent iterations of the course.

Surveys were given out to the student participants at the conclusion of the project, and consisted of five questions evaluated using a five level Likert rating scale, as well as three free response prompts. The major conclusions derived from the data are: 1) this assignment was enjoyable to execute, and useful for participating student to learn major concepts in the course, 2) the videos generated were useful in teaching their classmates, and 3) this assignment can be extended to other courses. Overall, the paper asserts that the pedagogy of using digital video projects as a means of learning through teaching helps in increasing conceptual understanding of course material, as well as useful to educate their peers. [1]

Introduction

Engineering education has traditionally been taught deductively. A lesson or topic starts out with principles or concepts, and then gradually works its way into applications and problems [2]. Unfortunately, the lecture based approach that has traditionally been used needs to be evolved in order to cater to a newer generation of students who are inherently more adept in electronic media, especially considering the popularity of sites such as YouTube and Khan Academy. This paper studies the effectiveness of learning by teaching through video media.

Today's generation of students belong to the 'net generation'. These students have had technology as a part of their lives practically since birth, and near constant access to the internet. This new breed of tech-savvy learners call for a new more interactive method of teaching, and are often classified as 'active-learners'. "Since the 1990s, research on pedagogy has shifted from what instructors teach to what students learn. And studies have shown students in traditional lectures courses learn comparatively little [3]". To engage active learners, new forms of media need to be used to bridge the gap between learning and the course material. "Student participation and even

leadership is critical when finding successful active-learning techniques [4]." Therefore, new media should encompass both lecturing and assignments.

Websites such as YouTube and Khan Academy can be a completely viable media to help students learn. Educators can use these sites to promote learning, by having students create content as a part of their course requirements. Creating and watching content from YouTube and Khan Academy allows students to "develop a deeper understanding of the material and can also provide an opportunity for experimental learning of not only the content, but the technology used as well"[5]. YouTube can help inspire and engage this new age of students who are more use to a digital learning style. Even the more traditional learner can use the sites as an opportunity to gain understanding in new technology, which can become skills for future careers [5].

The study was conducted over two years with the class of 2012 and 2013. Each year the students were separated into groups to create an educational video that illustrates a fluid dynamics concept that both engineers and non-engineers can learn from. A list of possible subjects to focus on was provided, but students were not restrained to those topics. The project was first assigned to a class of 2012 with 32 students. The students did not receive any additional resources, such as video editing software, to complete the project in the five week period. The next year the project was assigned to a class of 2013 with 35 students under the same conditions as the first year's group. The desired outcome of this study was to determine the effectiveness of using video media to enhance conceptual learning in an undergraduate fluids mechanics course. Some of the underlying pedagogical principles included learning by teaching, cooperative learning, and peer to peer learning.

Liberatore performed a similar experiment to the one detailed in this report, however his students were required to find a video on YouTube to show to the class [4]. He went on to confirm that the assignment "...successfully demonstrated a way to engage students of the Net Generation. Videos were used to reiterate recent class material, demonstrate robustness of the first law energy balance, and even introduce the students to advanced topics beyond a sophomore-level first course in thermodynamics" [4]. He also found that "videos created by chemical engineering students were very popular" an observation that reinforces the research performed in this paper.

Primary Principles

Many studies have been done on the effectiveness of project-based learning and most, if not all are in support of it. One study by Prince and Felder found that "students that participate in project-based learning demonstrate better communication and teamwork skills, and have a better understanding of issues of professional practice and how to apply their learning to realistic problems." They also went on to say that the students felt that they "saw more connections between theory and practice" and were provided more help from educators [2].

Learning by teaching is the process in which a person gains a better understanding of a subject by attempting to teach it. Learning by teaching originates from Dr. Jean-Pol Martin's method of allowing his students to prepare and teach lessons or part of lesson. Although this method is mainly used in foreign language classes, it can be applied to any field. After all, it is widely known that a person truly knows something when he or she is able to effectively teach it.

Furthermore, if a person is tutoring other students in a subject, the tutor can become more versatile in that subject.

The methodologies of learning by creating a video revolve around three core aspects: Study, Composition, and Assessment. The study occurs as students research the topic and start creating clips for the video assignment. The composition happens when students take their clips and try to create a coherent video. The assessment is when faculty critiques the videos and gives feedback [6]. The immediate goals of these methods is to increase the probability that students will understand the video based materials, to encourage them, through repeated viewing and manual interaction with the video content, and to be deliberate in validating what they see and in explaining the connections between their evidence and claims about learning. [6] The long-term goal of these methods is to help students develop a more contingent notion of truth that encourages them to contemplate different theories and supports further inquiry as well as new ideas for teaching. [6]

One of the prime objectives of this project was for students to learn through both the process of making a video that teaches their peers, and through watching the video itself. Learning through video production is a fairly unique task because it combines the elements of learning through teaching with the process of making a video. This method is learner-centered, "meaning that [teachers] impose more responsibility on students for their own learning than the traditional lecture-based deductive approach" [2].

The students' education develops directly from the actual production of the videos. In order to effectively manufacture a video on a subject, one must completely comprehend the topic from multiple perspectives. To solve a problem or question, the students must first originate one of their own; this thought process is inquiry-based. "Inquiry-based teaching assumes that students are involved in initiation of problems to investigate, searching for alternative solutions to the problems, collection and tabulation of data, reporting conclusions, and suggestion of new, related problems for further investigation"[7]. These steps lead "students to construct their own versions of reality rather than taking the one presented by their teachers" [2]. These methods involve some trial and error, as students change one variable at a time then observe the results, and are often carried out with students partaking in groups or cooperative learning. The analytical steps used in this method highlight trends that appear in problems such as the magnitude of the answer, the importance of units, any basic assumptions that could be made, etc. This also helps to smooth out any confusing or unintuitive steps that may appear in solving it.

Cooperative learning is a pedagogic method where students are separated into groups and use a variety of activities in order to promote academic and social development. Using cooperative learning, students are able to teach each other and improve skills. Each individual has a specific skill set, and some students are better in certain areas then others. Having the students in a cooperative group allows each student to excel in the specific areas they know while also allowing themselves to be taught by other group members in order to advance in skills they are not as efficient in. It allows each member an alternative to learn from instead of just the instructor. The emphasis in a cooperative learning classroom is on interpersonal contact and group processes are pervasive. In this type of classroom, students interact more and are more

interdependent on each other. Traditional classrooms have teacher lecturing and peer interaction is usually discouraged [10]. Even though this is the norm, research on learning in small groups shows that students can actually learn better when the teacher ceases to act as the authority of learning and the students become responsible in teaching each other [9].

In order for a group to be deemed cooperative, there are four elements that must be present: positive interdependence, individual accountability, face-to-face interaction, and group process [8]. Positive interdependence entails the members of the group to be aware of their dependence on each other. Individual accountability requires each student to be responsible for understanding the concept. Face-to-face interaction promotes each other's success and helps the students to learn from each other. Lastly, group process is where the members discuss how well their goals are being achieved and how to approve each other and their work. All of these elements must be achieved in order for the learning process to actually be considered cooperative learning. Simply putting students together without formatting the environment may cause few cognitive or affective benefits to develop. Cooperative learning demands student interaction, and effective interaction is influenced by several factors, including task structure, rewards, group dynamics and interpersonal skills [9].

The next step of video construction relies on coming up with a memorable and interesting medium to attract attention. This step is often one of the most perplexing because teaching with video is a relatively new and untested form of education [9]. In this study the most popular approach was to act out a scene where concepts from class would be used in a "practical" setting. This approach can be classified as a structure where "students are given a problem and an outline for how to solve it" [2]. These steps of the project closely follow a learning-through-teaching methodology.

The concluding step of video production is to use video editing software to edit and make the final product. This step can have a large learning curve if the students are not familiar with video editing software [11]. This step is also serves as the 'cutting room' so to speak "because students need to think about whether or not a video clip is appropriate to explain a concept and exactly what should be recorded to explain that concept"[7]. In addition depending on the medium used to teach the topic this step can also take the longest. For example, a group that used a stop motion medium spent more time editing scenes then actually filming them. This step is unique compared to the others in that it exposes students to something completely different than an ordinary engineering course.

In order for the video to be effective aid after being created it should follow the guidelines stated in a study by Rosher, an educational video should follow the rules of the four c's: Convenience, Consolidation, Communication and Community. Convenience denotes that the videos should be easily accessible, allowing students to watch the video on their own schedule. "The videos created should represent consolidated knowledge, either by providing pivotal information or by being an amalgamation of key learning objectives." [12] Communication and community go hand in hand, as it is impossible to separate the effects of both. The community encourages a shared opportunity to watch videos with others while communication around videos can take

place through many channels such as face-to-face, notice boards, email or virtual environment facilities. Using communication tools available in virtual environments, encourages a more dynamic approach to viewing video. For example, the opportunity to rate videos and write comments encourages students to engage more deeply with the video material. [12]

The social media site YouTube can be effective way of teaching for a multitude of reasons. The videos can be created to be enjoyable so students do not feel that they are studying or doing work. The student's can re-watch portions of the video until they understand the material. The videos can put in to playlists to allow coherent flow of course material. Since YouTube is available in twenty two countries, it's an excellent way for students from all over the globe to learn any sort of material, including engineering. In addition, viewers can comment allowing for communication between creators and viewers helping create a community feedback system. [13]

The actual video itself is a demonstration of peer-to-peer learning. If the video produced by the students satisfies the requirements and goals of the project, it can be used as an in-class aid to help introduce and teach the topic to the students. In one scenario, Gainburg would "use a video segment that illustrated a theoretical approach…or had the potential to drive rich discussion about a practice or learning theory" [11]. The use of video in the classroom also leads to a better understood topic as seen in a study by Eugene Rutz [14].

Results

After the projects were submitted the class watched all the videos and took a survey about the experience. Using a 5 level Likert rating where 1 = Strongly Disagree, and 5 = Strongly Agree. Table 1 displays the results of the survey (n = 59 respondents) [1].

	Question	1st Year Average	2nd Year Average
1	Making a video in this assignment was useful in learning principles in fluid flow	3.78	3.83
2	There was a large learning curve in producing this video	3.78	3.66
3	Participating in this project was enjoyable	4.22	4.34
4	I feel that students who have not taken this class will learn from the video my group produced	4.13	4.26
5	This assignment can be extended to other courses (e.g., thermodynamics, and material and energy balances)	4.13	3.59

Table 1 – Post-project student survey. A rating of 1 = Strongly Disagree, while a rating of 5 = Strongly Agree

The survey results clearly illustrate that the overall project was successful in both years. The results between the two years are almost identical except in the case of Question 5. Students were able to learn the principle they were teaching in the video (Question 1). In addition to the survey, there were three free response questions the students had to answer. The first question asked "What are the strengths of this assignment?" The majority of students in the first and second year agreed that making the video helped them better understand the topic; in addition

they found the project fun. Students stated that "you had to really learn the topic" as well as "forces students to understand concepts". The next question asked "What are the weaknesses of this assignment?" Many students answered that creating the video was the most difficult part. This explains the higher score for Question 2 in the survey. It was noticed in the videos that more attention was given to the production of the video compared to the subject matter most likely due to a large learning curve over how to actually make the video. Although many students found it hard to make a video without proper equipment, the students believe that the video is capable of teaching others. This explains the high score for Question 4 in the survey [1].

In the survey results for Question 5, the first year student's replies strongly show that assigning this project where can also be utilized in other classes. The second year students didn't rate the question as high, meaning that the video project would be not be able to be used for other courses. This lower mark is the opposite of what was expected. The second class overall said that the project more informative for the audience, more educational for the creators as well as easier and more fun to make than the first class. That being said it stands to reason that the second class would also find the project more applicable to other courses, but the results dictate that the opposite is true. There are two possible reasons for this rating, the first is that when replying to the question the students were thinking specifically more difficult engineering courses such as Transport Phenomena. The second possibility is that the students were simply tired after completing the project last minute and not eager to take on a similar project right away.

The last free response question asked "What changes/improvements would you make to this assignment?" Students requested that the topics should be assigned to them rather than them picking a topic of their choice. After further investigation on why students suggested this, students had selected topics they were already affluent in, meaning students gained less knowledge of their topics when compared to a subject they don't understand[1].

Conclusion

The goals of learning by teaching and cooperative learning is to improve on a variety of educational foci, such as teamwork skills, soft-skills, learning more qualitative than quantitative, and learning how to learn [15]. The chief factor that these methods have in common is the strong reliance on peer-to-peer interaction. This improves social skills among students by having them diversify while also helping a student feel more comfortable by asking questions to a peer instead of a teacher. The interaction also leads to a higher self-esteem of the student; as students actively participate in school life, their quality of work will improve and become more fun. Along with improving skills and learning, group learning can also cause improvement in attitudes towards other students; therefore less experienced students will gain self-confidence in temporary leader roles and gain standing in the class [15]. This combination of video learning and cooperative learning is an invaluable approach to engage students in usually complex material.

Based on the videos produced as well as the survey results taken afterwards, the assignment was a success on all levels. The process of making the video allowed the students to learn more about their topic, and watching other groups' videos students were able to learn the material through a different media than previously exposed. The project also gave the students an opportunity to be creative and gives them a chance to express themselves, which is often absent in the field of

engineering. Although the results changed from year to year, they were still positive. This conclusion bares merit that the students found the assignment to be effective at aiding them in conceptualization and understanding the topics in a fluid dynamics course.

There are a number of components that can be added to future studies. A peer review section will be added after the project is turned in, and will offer a chance for students to point out a group partner who did not participate as much as others during the assignment. This problem was noted by a few students in the "other comments" section on the evaluation form. Another way the project can be improved is by implanting the videos created over the past two years into the lecture portion of class. By doing so it the true effectiveness of the project can be measured, the students will receive a different interpretation of a topic, and the concepts will be reinforced in lecture. In addition, by having the students exposed to the previous year's successes, they'll know what medias work well and in what direction the assignment can go. The students get to see firsthand the effectiveness and potential their projects will have on the field of pedagogy. Another possible enhancement to this research would be to borrow a staple of Liberatore's project, the written assignment. But instead of writing about their own video they would write briefly about the previous classes' videos. This would encourage students to pay attention and to make sure they include all relevant information in their own attempts.

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