A PEDAGOGICAL STUDY OF LEARNING BY TEACHING THROUGH VIDEO MEDIA

Student Paper
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Introduction
Engineering education has traditionally been taught deductively. A lesson or topic starts out with principles or concepts, then gradually works its way into applications and problems [1]. 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. This paper studies the effectiveness of learning by teaching through video media.

The study was conducted by having students 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 assigned to a class of 32 and the students did not receive any additional resources, such as video editing software, to complete the project in the five week period. 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 metacognition, learning by teaching, and cooperative learning.

Primary Principles
Metacognition is an understanding of how an individual learns and “improves the likelihood of transferring information learned in one context to another.”[2] Many studies have been done on the effectiveness of project-based learning and almost 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 [1].

Learning by teaching is the process in which a person learns the subject they will be teaching as they are attempting to teach it. Currently, learning by teaching designates Dr. Jean-Pol Martin’s method of allowing his students to prepare and teach lessons or part of lessons. 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.

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” [1].

The primary form of education comes from the production of the video itself. In order to effectively make a video on a subject, one must completely understand the topic from multiple perspectives. To solve a problem or question, the students must first come up with one on their own. These steps can be characterized as a constructivist method leading “students to construct their own versions of reality rather than taking the one presented by their teachers” [1]. These methods entail 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 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 pedagogy where students are separated into groups and use a variety of activities in order to promote academic and social development. In order for a group to be considered cooperative, there are four elements that should be present: positive interdependence, individual accountability, face-to-face interaction, and group process [3].

Positive interdependence requires the members of the group to be aware of their dependence on each other. Individual accountability necessitates each student to be responsible for understanding the concept. Face-to-face interaction helps promote each other’s success and 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 [4].

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 [5]. 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 [4].

The next major part of video production relies on coming up with a memorable and interesting medium to attract attention. This is often one of the most challenging steps because teaching with video is a relatively new and untested form of education [6]. In this study the majority of groups decided to act out a scene where concepts from class would be used practically. This approach can be classified as structured where “students are given a problem and an outline for how to solve it” [1]. These steps of the project closely follow a learning-through-teaching methodology.

The final step of video production is using video editing software to edit and make the final product. This step can also be challenging if not familiar with video editing software [6]. Depending on the medium used to teach the topic this step can also take the longest. For example, the group that made a stop motion video spent more time editing scenes than 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.

Peer-to-peer learning
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” [6]. The use of video in the classroom also leads to a better understood topic as seen in a study by Eugene Rutz [7].

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 = 23 respondents).

<table>
<thead>
<tr>
<th>Question</th>
<th>Average</th>
</tr>
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<tbody>
<tr>
<td>1 Making a video in this assignment was useful in learning principles in fluid flow</td>
<td>3.78</td>
</tr>
<tr>
<td>2 There was a large learning curve in producing this video</td>
<td>3.78</td>
</tr>
<tr>
<td>3 Participating in this project was enjoyable</td>
<td>4.22</td>
</tr>
<tr>
<td>4 I feel that students who have not taken this class will learn from the video my group produced</td>
<td>4.13</td>
</tr>
<tr>
<td>5 This assignment can be extended to other courses (e.g., thermodynamics, and material and energy balances)</td>
<td>4.13</td>
</tr>
</tbody>
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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. Most importantly, 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 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 lower score for question two 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 four in the survey. The survey results for question five show that assigning students a project where they teach their peers can also be utilized in other engineering classes. 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.

Conclusion
There are numerous benefits to both cooperative learning and learning by teaching. Along with improving skills and learning, group learning can also cause improvement in attitudes towards other students. A student that is supported by his or her peers is far more likely to have a higher self esteem than a student that is neglected by his or her peers. This in turn can improve social skills among students by having them diversify while also making it easier for a student to feel more comfortable by asking questions to a peer instead of a teacher. As students actively participate in school life, their work will improve and become more fun. Lastly, inefficient students will gain self-confidence in temporary leader roles and gain standing in the class [8]. The idea 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 to learn how to learn [8].

The overall success of the assignment and the survey results show that a video media project is an effective way of illuminating students by having them create a video that not only teaches them but also their peers. The combination of video learning and cooperative learning is an invaluable approach to engage students in usually complex material. It also allows students to be creative and gives them a chance to express themselves, which is often absent in the field of engineering. Future success in this style of teaching also depends on if the media projects made can actually be used as an in class educational aid, which can only be proven through future study.
References


