Please Explain Solution: How Incorporating Video Responses Improved Student Performance in a Circuit Analysis Course

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Abstract

Circuit Analysis is one of many engineering courses that require a lot of collaborative problem solving by students. To motivate students to practice the taught techniques outside of class, they are frequently assigned homework.

The main challenge the author faced was to motivate students to put the required effort into homework problems. Students often tend to copy the solutions from others. As the course proceeds, such students begin to have difficulty in following lectures.

To overcome this challenge and motivate students to solve their homework problems by themselves while collaborating with other students, the author makes it compulsory for each student to record a video explanation of his or her solution and share it with the instructor. To encourage collaboration among students, students are grouped in teams of two.

The author observed a very significant improvement in student exam performance and in student perceptions about course after incorporating the video explanations.

Keywords

Homework, video explanation, collaborative learning, pedagogical innovation.

Background and Introduction

Circuit Analysis is a foundational course for Electrical Engineering students. It is also a compulsory course for many other engineering majors. Learning the skill of circuit analysis requires a lot of practice from students. It also requires students to discuss their solutions with their peers and learn through collaboration. Instructors often incorporate in-class problem solving by students working in groups. However, the limited collaborative problem solving during class is not enough for students to attain the satisfactory level of achievement needed for circuit analysis. To motivate students to practice the taught techniques outside the class, they are frequently assigned homework. Homework reinforces the course material taught in the classroom and allows students to grasp the concepts through problem solving at their own pace, which builds self-confidence. It also allows students to collaborate with their classmates to solve the assigned problems.[1,2] The fact that course content builds progressively upon earlier taught techniques in circuit analysis further adds to the importance of problem solving by students outside of class.

The main challenge the author faced while teaching circuit analysis was to motivate students to put the required effort into homework problems. Collaboration with peers to solve homework

problems is always desired; however, it can also lead to students copying the solutions from others. Advancement in technology has made it easy for students to share solutions among themselves. Solutions to many problems can also be found on internet[3,4]. The purpose of homework is defeated when students copy homework problem solutions[5]. The author has observed in her circuit analysis course that when students copy solutions; they not only lack the expertise of utilizing a particular circuit analysis technique but also find it hard to learn new techniques taught in class. As the course proceeds, such students begin finding the lectures hard to follow and get frustrated. The lack of learning is indicated by the exam result statistics and student frustration indicated by the course evaluation.

This paper explains how the author has managed to motivate students to solve homework problems by themselves through incorporating video responses. The next section explains in detail how this approach is implemented. Finally, the results of both student examination grade distribution and course evaluation are presented. These results show very significant improvement in both student learning and their perception about the course.

Method

To overcome the challenge of motivating students to solve homework problems by themselves while collaborating with other students, the author has utilized technology. Several studies have found explanations of solutions during oral examinations to be more effective than a traditional written examination[6,7]. The author has extended the effectiveness of oral examination success to homework assignment submission. Modern technological advancements are utilized to overcome the meeting time requirement for an oral examination. These days it is very easy for students to record the explanation of their homework solution as a video. Similarly, there are many applications which allow easy access to sharing these videos.

When students are required to explain their solution, they need to understand it even if they have copied it. It should be noted that students are required to submit their hardcopy homework as well. However, the students' video explanation carries most of the weight when determining the grade for the homework assignment.

Since, video explanations make a student's effort quite transparent, author increased the weight or value of homework in the overall grade. This further motivates students to solve homework problems so well that they can explain their solution to others. The author is also willing to drop two minimum scores to make up for a time when students could not study for the course if they have a genuine excuse.

Video Sharing

The author makes it compulsory for each student to record a video explanation of his/her solution and share it with the instructor. Cloud saving and the sharing application, *Dropbox*[8], is used to share video explanations. The instructor mentions this strategy of homework submission in the course syllabus and briefly explains the video submission process while discussing the course syllabus in class. Near the submission deadline of the first homework assignment, the instructor takes 5-8 min. during class to demonstrate how to utilize the *Dropbox* application for

sharing video explanations. Students submit the link of shared *Dropbox* folder with instructor on *blackboard* educational software[9]. The instructor usually assigns three to five problems in each assigned homework. No time limit is set to explain the solution of an individual problem or overall homework. The instructor observed that most video explanations take 5 – 10 min. for each homework assignment.

Collaborative Learning

While copying solutions adversely affects student performance, working in collaboration with peers helps learning[10,11]. To encourage collaboration among students, students are grouped in teams of two for each homework assignment. Students in each group are supposed to work together on the homework problems. However, each of them submits the solution of all problem individually. Homework is graded based on student's individual performance as well as overall group performance. Group performance points are deducted if one of the team members has significantly lower score in individual performance as compare to the other team member. Significantly different individual performance of group members means students have not worked collaboratively. Homework is graded based on each student's individual performance as well as overall group performance. Homework problems are assigned each week and groups are changed for every homework assignment. This way, students get a chance to work with different classmates each week.

Table 1 shows the procedure the author uses for creating different groups each week. Student names are listed in two columns, and each row defines one group. For every new homework assignment, the list of students is rotated counter-clockwise one step while keeping the first student in Group 1. This way each student finds a different group partner for each assignment. This method allows the creation of N-1 different groups for a class of N students.

Group Set 1		
Group 1	Student No 1	Student No 20
Group 2	Student No 2	Student No 19
Group 3	Student No 3	Student No 18
Group 4	Student No 4	Student No 17
Group 5	Student No 5	Student No 16
Group 6	Student No 6	Student No 15
Group 7	Student No 7	Student No 14
Group 8	Student No 8	Student No 13
Group 9	Student No 9	Student No 12
Group 10	Student No 10	Student No 11

Group Set 2		
Group 1	Student No 1	Student No 19
Group 2	Student No 20	Student No 18
Group 3	Student No 2	Student No 17
Group 4	Student No 3	Student No 16
Group 5	Student No 4	Student No 15
Group 6	Student No 5	Student No 14
Group 7	Student No 6	Student No 13
Group 8	Student No 7	Student No 12
Group 9	Student No 8	Student No 11
Group 10	Student No 9	Student No 10

Table 1: Method of defining new groups

Results

The author observed very significant improvements in student performance after incorporating the video explanations. Student exam results improved, their interest and participation during class time increased, and they began considering the course as more enjoyable and less difficult.

Examination Results

The exam results improved significantly after incorporating the video responses in the circuit analysis course. Figure 1 shows the final grade distribution for classes which included traditional homework submission as hardcopy and the grade distribution for class which included video explanations of homework problems.

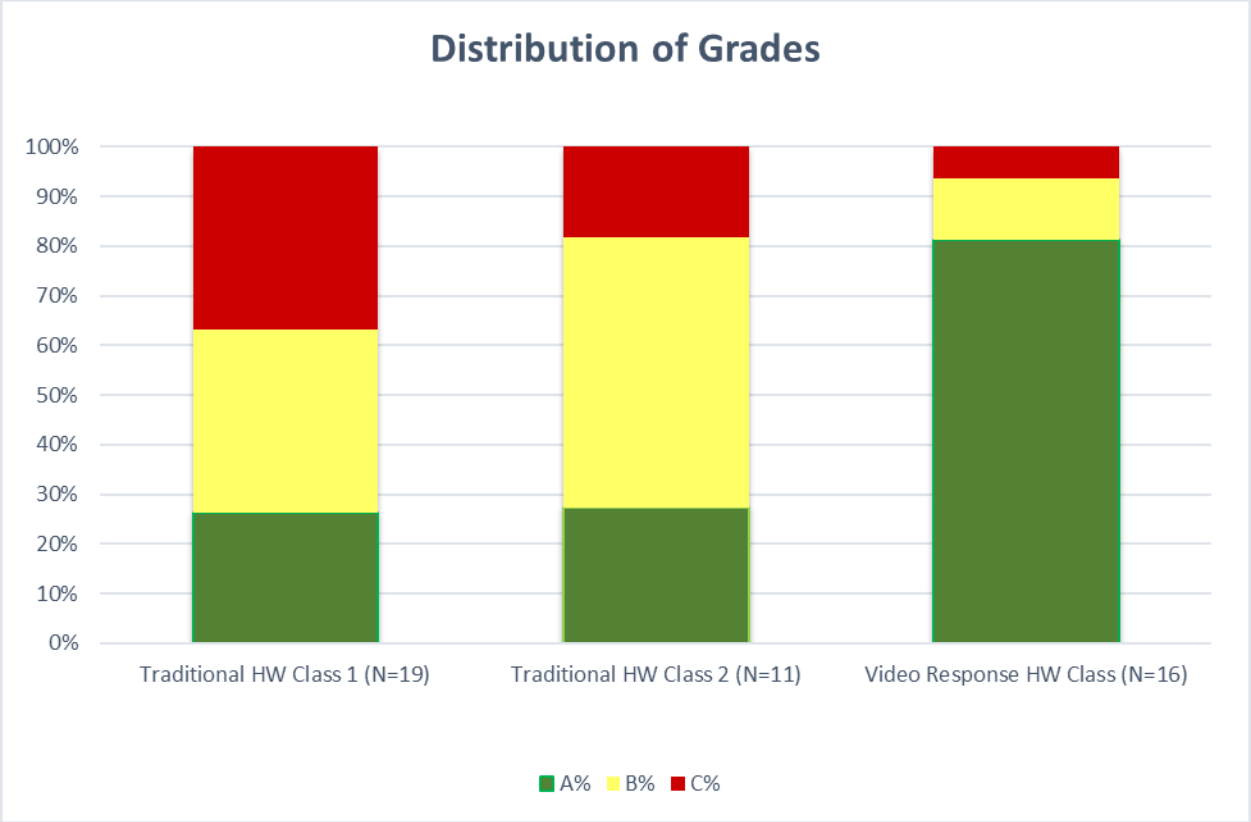

Figure 1: Graph of final grade distribution for classes with and without video response homework

The first class, which involved traditional hardcopy homework submissions, had a total of 19 students in class, and the final grades were distributed quite evenly as three grades, namely A, B and C. The next class with traditional homework had 11 students. The grades distribution for these classes are not statistically different (p-value 0.52). The class in which the author included a video explanation of homework problems had 17 students enrolled but one student was auditing the course. The grade distribution for this class shows a significant increase in number of Grade A results and consequently decrease in number of Grades B and C. The grade

distribution for the class with video responses is statistically significantly different from the traditional homework classes (p-value < 0.05).

Course Evaluation Results

The course was perceived as very difficult by students when they were assigned traditional hard-copy based homework submission. They used to find it difficult to grasp the concepts taught in class. From this author's perspective, this was due to the shortcomings in learning created by copying the homework problem answers from other student papers. Figure 1 shows the student ratings of instructions using the IDEA evaluation system[12]. The IDEA ratings for only one class with traditional hardcopy-based homework was available; this class had 11 students enrolled and 10 students participated in an anonymous IDEA survey. The class which involved video explanation-based homework had 17 students enrolled and 14 participated in the IDEA survey. The IDEA survey asked questions about the rating of course-relevant objectives and summative questions along with qualitative feedback. All ratings were rated on a Likert scale of 1 to 5 where 1 is least desired and 5 is most desired. Figure 2 lists the summative questions. Figure 3 shows the average of ratings for progress on relevant objectives and average of ratings for summative questions. These ratings show drastic improvement after incorporating video explanation-based homework in class.

After incorporating video based homework based on students IDEA evaluation results, they start to perceive the course less hard, learn better and have a better learning experience. Difficulty of subject matter was rated significantly lower from 4.2 to 3.5. Students overall perception about the course and instructor also improved greatly. The qualitative comments received from IDEA system indicated this positive change in student perception.

Summative Questions
1) Excellent Course
2) Excellent Instructor

Figure 2: Summative questions

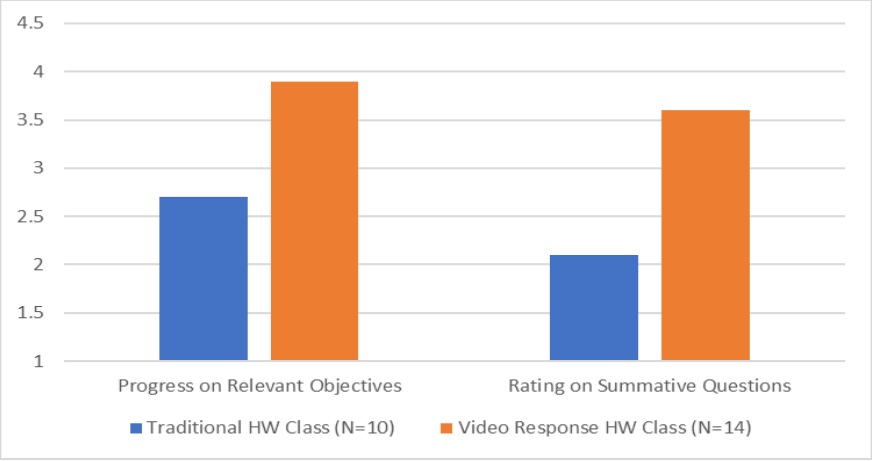

Figure 3: Course evaluation results for classes with and without video response homework

Conclusion and Discussion

Overall the practice of requiring video explanations as a part of homework assignments has been very effective in improving student performance and perceptions of both the course and the instructor. This approach was implemented for the author's Circuit Analysis course however it can be extended to any other course which requires students to practice problem solving.

Of great interest is the fact that students praised the course and instructor after video-based homework was incorporated. Nevertheless, their only suggestion for improvement in the course was to get rid of videos! They found them time consuming. Students generally spent less than 30 minutes recording their video explanation for each homework assignment, according to the informal feedback obtained from students.

The main disadvantage of this approach is the increase in grading time. Watching all video explanations takes quite some time. This problem makes this approach harder to implement without any modification for larger class sizes.

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