

The effect on perceived and performance learning outcomes from active online learning

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Abstract

Online teaching is rapidly integrating into courses at all levels of learning. This wave of online education was coming with Generation - Z; however, the pandemic catapulted the movement of online learning in ways educators never thought possible. GenZ is the first truly digital native generation meaning they are excellent at engaging with multiple devices (5 or more) at a time, therefore simultaneously filtering "un-important" information. While this skill is a superpower in some situations, it is challenging to focus on a single device in an educational environment like an online lecture. Therefore, this work investigates using active learning in an online course to determine the effect on students' *perceived* and *performance learning outcomes* based on *time of engagement* with the material compared to traditional passive online videos. Active lectures require students to continually engage with the video via practice problems and immediately watch solutions for incorrect questions. This work compares two modules in an online engineering economy course. Students choose to opt into the active group or remain in the passive group. Perceived learning outcomes are measured based on responses to a survey in which students indicated their ability to apply topics in a real-world scenario. Performance learning outcomes are measured by a student's performance on the midterm exam. Since this is a work in progress with only one semester of data, we hypothesize that students in the active group will have a higher time of engagement with the material and, therefore, higher performance learning outcomes. There is no evidence to suggest that students have higher confidence in their knowledge (better-perceived learning outcomes) based on their group (active vs. passive). Audience: Anyone teaching an online course with mathematical content.

Introduction

Engineering Economy is a course that teaches students the concepts of "Time Value of Money." This course is often taught as a "service" course, meaning that many different majors may be enrolled in the course in a given semester, and it usually has a high enrollment. At the University of Florida, this course is taught three semesters a year (Fall, Spring, and Summer), with enrolments averaging 160 students per semester. The course has been taught online for the past decade to accommodate many students from different engineering majors, including Industrial, Mechanical, Aerospace, Civil, and more. Although the course has been redesigned recently with the help of an instructional designer, course evaluations are still below the department's mean. Students continue to request more examples to practice and more interaction with the material. However, most students do not engage with the material currently provided and instead use online resources to find answers to questions. Therefore, this work tests the theory of whether active online lecture videos can improve the time of engagement with the material, perceived and performance learning outcomes, and possibly increase course evaluations.

Literature

Active Learning Framework

The theoretical frameworks of Behaviorism [1] and Cognitivism [2] support that learning is best achieved when supplemented with activity [3]. Behaviorism indicates that when students perform a behavior, they learn that topic on a deeper level. For example, consider a class in college that you felt was the most useful. Most of the time, that class had a lot of examples and practice in class in which you could apply the material. Cognitivism allows students to apply the

topics through open-ended assignments like case studies or group discussions to better learn the topic [4]. By applying the concepts directly in activities in class, students can achieve a higher order on Bloom's taxonomy (analysis, synthesis, and evaluation) [3].

Active Video Framework

However, for an online course that reaches over 160 students a semester, including "active" exercises, is not straightforward since students work at their own pace in an online environment. In addition, students often complain of attention wandering and lack of immediate feedback in an online course, and they expect high-quality videos [5, 6, 7]. Active videos were created to continuously engage students, provide real-time feedback, and provide high-quality videos to address these concerns. In this study, the test group watched an *active video* that interjects required interactions in the video during the lecture. The control group watches a traditional online lecture video and completes a follow-up quiz at their own pace after. The interactions in the active video and the quiz questions for the control group are the same questions with different values.

Time of Engagement Framework

Although active learning shows better retention and performance results than traditional methods, passive methods are still most popular in courses with large enrollment [8]. Students often have an inherent negative bias toward active learning, as it is sometimes perceived as "too much work" or requires "forced interactions" [9]. However, the more time a student engages with the material can positively affect their performance [10]. Students are not successful at estimating the amount of time they need to engage with the material to retain the information successfully [11]. Students also struggle to evaluate their perceived learning from an active learning environment. Therefore, in an active learning environment that increases engagement time with the information, a student's performance should also increase; however, their perception of that interaction may not match their actual retention. For example, students in an active learning study did not perceive their learning as high as those in the passive group, although they performed better on the material [12]. This could be due to instructor delivery or a general misunderstanding of the effectiveness of active learning methods since they differ from what students expect in the classroom [12]. Therefore, students may be resistant to active learning due to the increased time of engagement with the material and the perceived notions of traditional methods. However, they typically have higher performance indicating active methods are more effective than conventional passive methods.

Methods

Passive online interactions are a series of online lecture videos followed by weekly quizzes. The videos are not monitored for completion. The follow-up quizzes are timed, and students have two attempts. These quizzes are worth 15% of the overall grade and are intended as a learning opportunity for students, not to measure how well they understand the material. This group is the control or passive group. There were six videos and three quizzes in the control group.

Active online interactions are a series of videos where the quiz questions are built into the video lectures as interactions during the video. After presenting a formula or topic, students are presented with a follow-up question in the video. They have 2 attempts at the question. After the first attempt, they have the option to watch the solution video before making their second attempt. Solutions are solved with different values than those presented to the students, so they

must solve their specific problem on their second attempt. The videos and the questions in the active videos are the same as the passive videos and quizzes, just presented in a different method. Students can speed up and skip through the video during the active videos but they must complete the interaction before moving on. This group is the test or active group. There were four videos, three of which contained interactions in the active group.

Students enrolled in Engineering Economy in Fall 2021 chose to opt into the test/active group or remain in the control/passive group. There is no clear understanding of why students self-selected into each group. However, based on anecdotal evidence, those that do not opt-in often think it will be "more work" than the traditional method. Students could only see their respective assignments in their portal. Meaning the active group could not see the passive quizzes and vice versa. There were 178 students enrolled in the course and 151 opted for the active module, and 27 opted to stay in the control group. The difference in sample size is substantial and is a significant factor for this work being presented as "work in progress." More semesters of data are required to compare groups accurately. The same methods are currently being deployed in the Spring 2022 semester, in which 240 students are enrolled in the course, 148 have opted into the active group, and 92 in the control group.

Research Question: Do active online lectures affect the time of engagement, perceived learning outcomes, and performance learning outcomes compared to traditional online lecture videos?

Time of engagement (TOE) is defined as the amount of time a student spends with the material. 100% indicates that the student spends precisely the length of the video on the assignment. Where 50% would suggest, the student spent only half of the length of the video with the material. Meaning a student could have sped up the video or skipped parts of the lecture material. 150% indicates that a student spent 50% more time with the material than the original length of the video due to pausing and working out problems. TOE for the control group is calculated by the sum of the video time plus the total time students on the follow-up quizzes on both attempts. This method assumes that students are watching all of the lecture videos, which is a limitation of this work since the video platform for the control group does not collect TOE. Instead, it collects the furthest time the student watched in the video. For example, if the student opened the video and skipped to the end, it would consider the video watched 100%. The active platform collects genuine TOE by monitoring students' time working in the tab. The limitation with this method is if a student leaves the tab open and their computer on, it will continue counting. Therefore, to remove outliers, the average TOE of the active group was calculated, and any value outside of three standard deviations from the mean was removed. This process was completed two times to create the final data set.

Perceived learning outcomes are measured using a survey where students were asked questions such as "While getting a car loan, the application mentions simple and compound interest, how confident do you feel that you could decipher the interest on the loan?" or "How likely are you to be able to explain the concept of "time value of money" to a friend?" These questions were asked to see if students in either group felt more confident with the material.

Performance learning outcomes are measured based on students' performance on the midterm exam. There are two parts to the exam. Part I is online, proctored, and timed, while part II is take-home. Part I helps mitigate the possibility for students to cheat since their computers are locked to the exam and video-monitored. Therefore, the outcomes from part I will be used to measure the performance learning outcomes of both groups.

Results

There are 141 students in the cohort, with 27 in the passive/control group and 151 in the active/test group. Since the groups are drastically different in size, all results will be inferences to make hypotheses about what we expect to see with more data points. TOE is higher in active videos 3.1 and 3.3; however, 3.2 is slightly less than the passive videos (figure 1). In 3.1, the active group spent 200% of the original time with the material on average, whereas the control group averaged just below 150%. In 3.2, the groups are very similar. In 3.3, the active group spent 244% of the original time with the material, whereas the control group only spent 150%. There was no average or statistical difference between the groups for any of the questions in the survey. This suggests no difference in perceived learning outcomes between students who were in the control group or the active group.

The average score on part I of the midterm exam for the active group was 80.5 and 73.7 for the passive group indicating that students in the active group have better performance learning outcomes (figure 2). However, a two-sample t-test with the assumption of equal variances resulted in a p-value of 0.0503

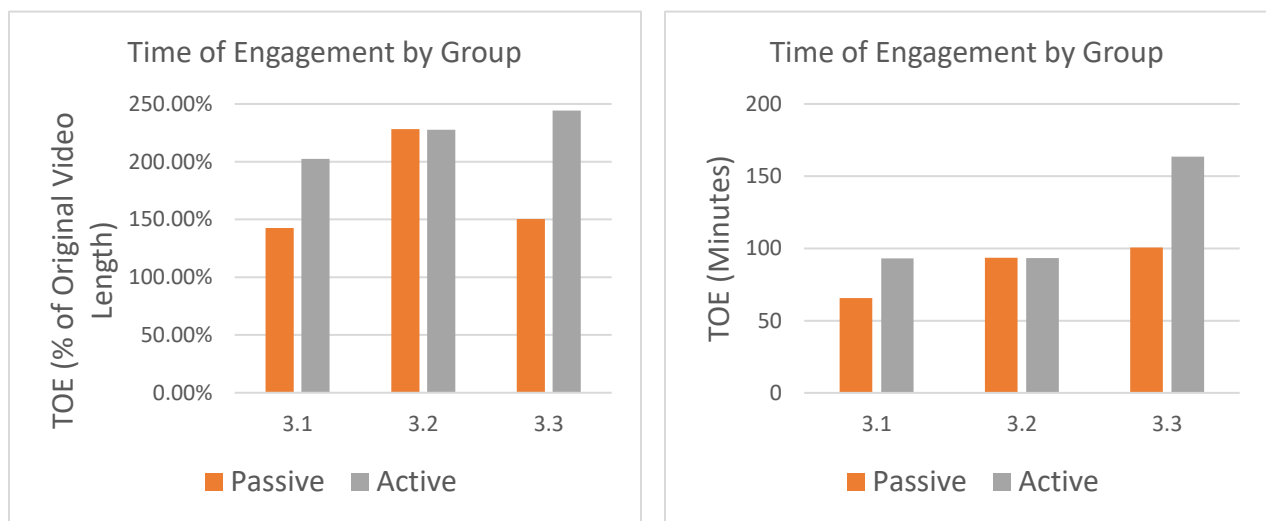


Figure 1: (Left) TOE for each group by percent of the original video. (Right) TOE for each group by total minutes of engagement.

Discussion and Future Work

We realize there is a significant difference in the group sizes (29 vs 141) in this work. Therefore, all results are presented as hypothetical or suggested trends and will be used in a larger data set of future semesters. There are no results at this point to indicate there is a difference in perceived learning outcomes of the two groups since there was no observed difference in any of the survey questions.

There is an observable difference in performance learning outcomes between the two groups based on the performance in part I of the midterm exam. However, a two-sample t-test revealed a p-value of 0.0503, indicating that the difference in the data may not be strong. There is also an

observable difference in the shift in inter-quartile ranges and median which show better performances for the active group than for the passive group. Therefore, the data suggests a positive correlation between the active group and their performance learning outcomes, but more data is required to make this conclusion.

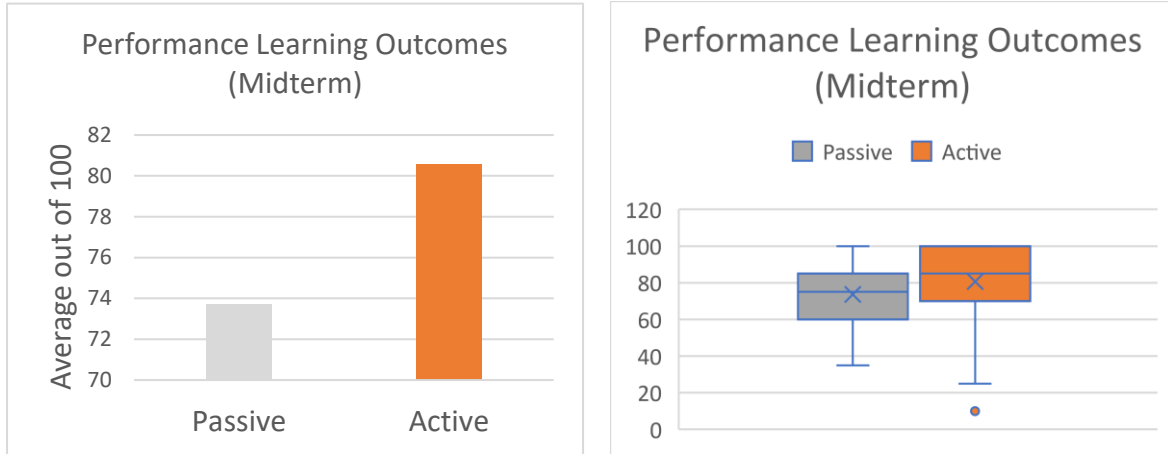


Figure 2: Performance of each group on part I of the midterm exam.

Based on the initial results from one semester of data, it is suggested that students have a higher engagement time with an active learning online module than a traditional lecture video followed by an assessment. In the active platform, students may investigate why they got a problem wrong by immediately watching how to solve the problem. In a passive environment, they would need to wait to talk with an instructor or review solutions later, decreasing the likelihood of reviewing their performance. When students are continuously engaged with an active assignment, it may trigger more interest in the material.

In previous work, the team evaluated the interaction time of students in a flipped learning modeling course[5]. Students overwhelmingly preferred a single long video to several short videos in that work. However, there was a noticeable trend of decreasing engagement as the semester continued. Based on this sample data, engagement increased throughout the module. Therefore, there may be cause to say that active videos keep students engaged not only during a video but also between videos. The course will need to deploy more active modules to test this theory in the future.

Since the active group had the ability to skip through the video, a count of students whose TOE was less than 80% of the original length were evaluated to see how many students were skipping through the videos to the interactions to complete the assignment. In 3.1 there were 9, in 3.2 there were 7, and in 3.3 there were 12. Indicating that less than 8% of students skipped through the material to the interaction to complete the assignment. We would like to be able to compare this with the number of students in the passive group who do not watch the videos before taking the quiz. This is data the team is currently working to collect.

Some students experienced problems with the playback of the platform. The active platform used for this work requires a strong and steady internet connection. Some students found that their connection was not reliable and had to use campus resources to complete the assignments. This was not a problem for the passive group.

Based on the Fall 2021 semester results, this work is being repeated in Spring 2022 to increase the sample size. In the Summer 2022 semester, another module will be converted into an active video series. Students will again opt into the method they would like to interact with for each module. Will students stay with the active method or switch? To better capture the TOE for students in the passive group, starting in the Summer 2022 semester, the passive videos will be moved to a different platform that captures TOE more accurately. Time of engagement and the effect on perceived and performance learning outcomes will continue to be measured.

Future work will also analyze a second survey sent to the active group after completing both an active and a passive module. This survey asks students to compare their experiences. Course evaluations will be analyzed, and text analysis from both surveys and course evaluations will identify themes among students' opinions.

In conclusion, this work-in-progress is beginning to determine if changing the way we present material in an online course to an active learning method will increase time of engagement, perceived and performance learning outcomes and student satisfaction with the course.

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