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Exploring the Impact of Student-Created Review Videos in Two Early Computing Courses

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Abstract

Research on student-created content videos (SCCVs) has highlighted their benefits in promoting active participation, reducing cognitive load, fostering creativity, and enhancing student independence. However, the specific effects of student-created review videos (SCRVs) in computing courses remain under-explored. In this study, we examined the impact of SCRVs on student exam performance in early computing courses. This experimental study was conducted in two different courses at a large public university in the southeastern US during Spring 2024. In each course, we randomly assigned students to an experimental group, who were tasked with creating SCRVs, and a control group, who were not. We compared the exam scores of students by condition. We also compared the exam scores of students based on whether they submitted in the last 3 hours before the deadline or not. We found that, in Course B, the average exam score was higher in the experimental group, while in Course A, there was no significant difference in average scores. We also found that early video submission (before 9 PM on the due date) was correlated with higher exam scores and vice-versa.

Introduction

Historically, prior programming experience and self-efficacy have been shown to lead students to do well on exams during introductory computing courses [1]. Furthermore, generating teaching materials with audio and visuals, not specific to computing, has also been shown to have a positive impact on students. [2]. This finding indicates that SCRVs on exam content may positively impact a student's exam performance.

Another area of research is peer teaching, also known as peer instruction or peer learning, which is a common tactic in classrooms where students aim to increase their knowledge on a subject by teaching the content they are trying to learn [3]. Peer teaching can come in many different varieties [3]. Furthermore, peer teaching has been identified in other scientific disciplines such as physics to be one of the most widespread and positive forms of learning [4].

Combining the concepts of video content creation and the positive impact of peer learning, this research paper investigates the hypothesis that incentivized peer teaching via short SCRVs may lead to a positive impact on student's learning in computing. Therefore, the first research question we strive to answer is **RQ1: "What impacts, if any, does peer teaching via students creating SCRVs have on exam scores in early computing courses?"**

Previous work has also linked procrastination with poorer emotional well-being and lower exam performance [5] particularly in computing classrooms [6][7]. This leads to the concern that students who participate in the research study but wait until very close to the submission deadline will not be impacted positively by the activity, and could even perform worse. Because of this, we hypothesize students who submit late will perform worse on the exam than those who submit early. Therefore, we aim to answer another research question via our study: **RQ2: "What is the difference in exam performance, if any, between students who submit their SCRV assignments close to the deadline and those who submit earlier?"**

Background

Three subsections of relevant prior research have been identified for this study. These subsections are impacts of videos and multimedia on learning, impacts of student-created content on learning, and the impact of procrastination on learning.

Videos on Learning

A study by Brame et al. shows how videos have become an important aspect of higher education and there is plentiful benefit [8]. The study also aims to find aspects of the most successful educational videos. Specifically, the study looks at cognitive load, student engagement, and active learning aspects of educational videos. With these factors in mind, the study concludes that the most effective videos are brief and use audio, visual, and interactive elements [8]. Considering this study, students in our study will be encouraged to make their videos brief (under 5 minutes), create visual presentations, and include exercises which could be interactive within their videos.

Another study by Noetel et al. was run to observe the impacts of videos provided in addition to traditional style lectures, and found that swapping previously existing teaching methods for videos led to small improvements in learning whereas providing videos in addition to previous methods greatly improved learning [9]. Relevant aspects found that could lead to this improvement include videos being asynchronous, which allows the creators to edit and review, as well as students being able to control their cognitive load by pausing and rewinding [9]. It is important to note that students participating in our research study will be able to create their SCRV at their own pace, allowing for them to take breaks and digest the content they are teaching similarly.

Finally, Ramly et al. ran a research study in 2023 on the effects of educational videos in online learning in computing [10]. This study is specifically relevant due to its inclusion of 43 randomly selected computing teachers. This study used a variety of surveys to determine the impacts of educational videos quantitatively. The surveys revealed that in computing, educational videos help attract student's interest, assist students in understanding topics, and that students on average found the videos to be fun, not boring, as compared to traditional assignments [10].

Student Created Content on Learning

A study by Doyle et al. in 2020 established that students creating their own materials can lead to deeper understanding and comprehension [11]. This study observed two main methods of

student-created content: multiple choice questions and videos. The study did not focus specifically on computing and engineering students but found significant increases in performance among students who made both multiple choice questions and videos [11].

Another study expanding on specifically “student created content videos” by Henry Greene et al. found that students are able to be trained to create reasonable videos within 30 minutes [12]. This study was performed on three sets of six students in a direct marketing class. The experiment came back with significant increases in academic performance, greater confidence on the subjects for which the videos were made, and students taking more control over their own assignments [12]. Greene mentions that future research needs to be done to determine whether his findings uphold in greater numbers of students and in other fields [12].

Finally, a short study by Guillermo Feijóo-García et al. has determined that ”student-created instructional videos” have assisted students and compelled them to learn specifically in computing courses [13].

This study aims to build on previous studies and establish whether there is a cause-and-effect relationship between SCRV and higher scores on the exams. What differentiates this study is we aim to quantify the impact of SCRVs in specifically computing classrooms.

Procrastination on Learning

It is already confirmed that academic procrastination has an impact on impulsivity, perfectionism, anxiety, depression, and quality of life [14]. Furthermore, academic procrastination leads to guilt, poor self-esteem, and 40% of students in a study by Ahmed Iffath reported having lower academic performance [15]. This study aims to take into account the effects of procrastination on academic performance and further explore whether submission timing affects the impact of SCRVs on course exams in a new context of student-created review content in computing education.

Methods

Study Design

This experimental study was conducted at a large public southeastern institution in the US during Spring 2024. The study was conducted in two courses, one concerned with programming fundamentals in C++ (Course A), and the second concerned with data structures and algorithms in C++ (Course B). Students from these courses were randomly assigned groups at the beginning of the semester, either being placed in Group 1 or Group 2. Each student was required or allowed (depending on the course) to create an SCRV for one of the exams in the class using a cross-over study design [16]. Group 1 students created an SCRV for Exam 1, and Group 2 students created an SCRV for Exam 2, on a relevant topic on the corresponding exam, due before the administration of that exam. While both courses have a similar structure with three traditional lectures per week and one weekly discussion period, due to instructional decisions Course A required all students to submit an SCRV in order to take the exam, while in Course B students were offered extra credit if they created the video.

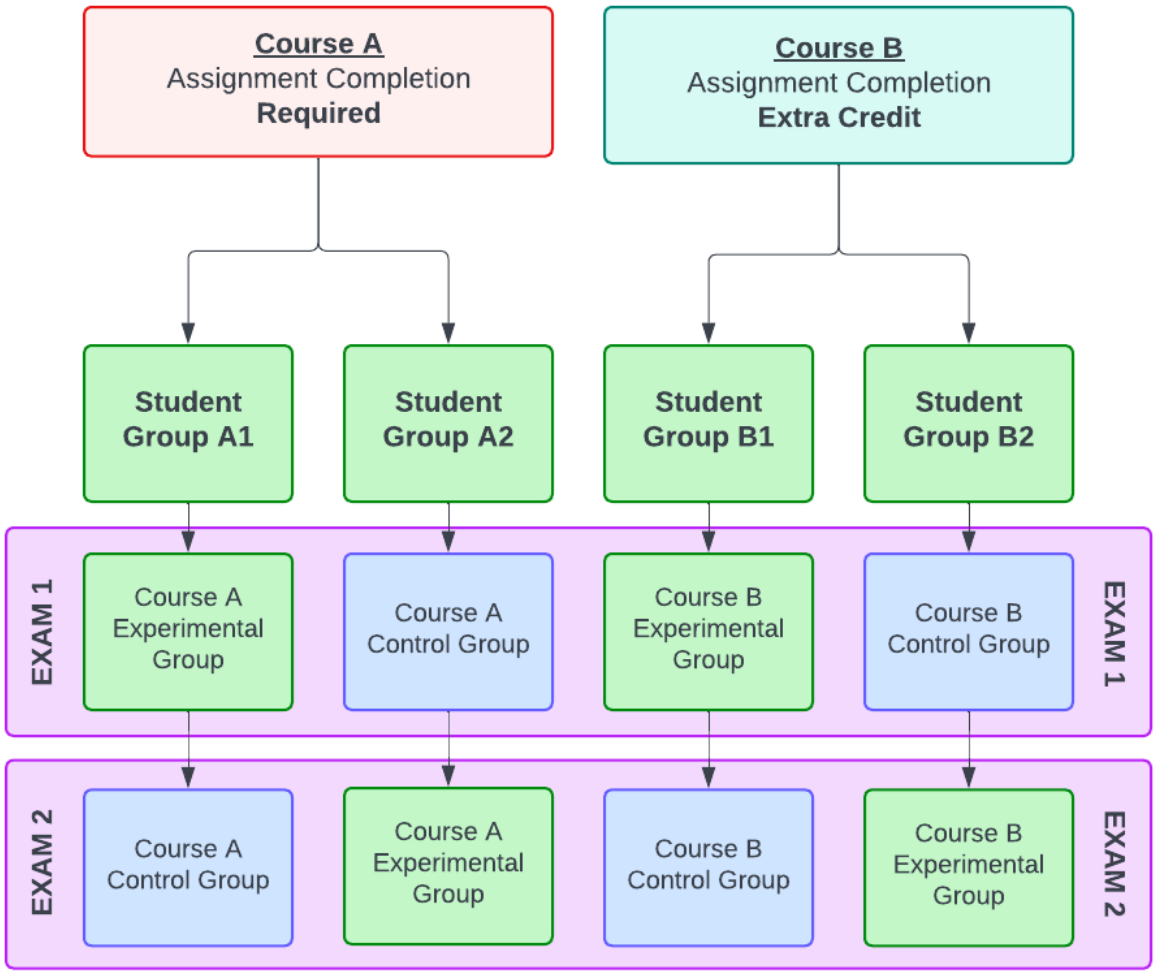

Figure 1: Visual Representation of Experiment Design, Specifically Divison of Student Groups by Course and Exam

Having two distinct courses with different instructional approaches, content, and assessments allows for a more robust design, in addition, swapping the groups for the next exam also limits the possibility for one group to perform better due to external factors. Given that the two courses had some key differences in the exams we will discuss these differences in the next two sections.

Course A

The exam for Course A consisted of five practical programming questions. This exam was an in-person exam and students had two hours to take the exam. This exam was double proctored with students proctored by humans in the room and Honorlock. The five questions would be inside of an integrated development environment and would involve reading a problem,

programming a solution in C++, and passing test cases. Scores were assigned to students automatically based on how many total test cases they were able to pass in each of the five programming problems.

The experiment in Course A was implemented directly into the course as a normal assignment required to complete by all students. Students were required to submit a consent form at the beginning of the semester for their data to be collected and were allowed to opt-out at any time for any reason. However, even if a student chose to have their data removed, students were still required to complete an SCRV before the exam they had been randomly assigned to as a normal class assignment. All students were required to submit the video, and this resulted in Group A1 being of size **N = 332** and Group A2 being of size **N = 333**. This specific design allows us to expand on our understanding of SCRVs without the confounding effect of motivation.

Course B

The exam in Course B contained an auto-graded multiple choice section worth 70% of the grade and a free response pseudo-code portion worth 30% of the grade which would be manually graded by the course teaching staff. The experiment in the Course B was implemented as an extra credit opportunity for students. Students were required to take a pre-survey, which consisted of the consent acknowledgment and a few questions to measure confidence in computing. Furthermore, students were required to complete a pre-test to acknowledge and account for the case that some students may have more initial knowledge than others on the subject leading to better performance. If students correctly completed the pre-survey, pre-test, and SCRV, they would receive a 1% extra credit bump in their grade. The course also had other options available for this 1% extra credit bump, and thus, participating in this experiment was not necessary to receive the maximum grade in the course. Students needed to sign up for the experiment within the first 3 weeks of the course, and afterwords were split into the randomized groups. Students were only compared to other students who also signed up to participate in the study.

The goal for this implementation of the experiment was to see the impact of SCRVs when it was the student's choice to participate. Because students had the option to participate in other activities to receive the same amount of course credit, only students who wanted to create SCRVs were likely to participate in the experiment in Course B.

Procrasination

For this study, submissions prior to 9 PM the night before the exam will be considered "early" and submissions after 9 PM will be considered "late". 9 PM was chosen for two reasons. One was that the assignment could reasonably take up to three hours for a student to complete, so by submitting before 9 PM a student is submitting at least one assignment's length (3 hours) before the deadline. Furthermore, given the exams happen the next day in the afternoon and students are likely to have classes in the morning, students working on the exam review past 9 PM run the possibility of having sleep deprivation, which is also a cause for lower academic performance [17]. A cutoff of 9 PM ensures that a student has proper time after completing the assignment to get a full 8 hours of sleep prior to the day of exam. Therefore, we will use this benchmark to determine if there is any difference between students who submit early and late. Furthermore, in the case there is no

difference between control group and review group, we can continue to analyze if there was a difference under the assumption students did not submit later than 9 PM.

SCRVs

In both courses, the SCRV had an assignment created through the course Canvas page, which explained all details. This included the approximate required length of 5 minutes, the allowed topics per exam, the due date of the video, and how to create an SCRV. Students were encouraged to use existing course materials, create their own materials, and do research beyond the course in order to adequately teach one topic for the upcoming exam. Student's SCRVs were manually verified by research staff to be on legitimate topics covered on the exams and to be made by the actual students themselves. This entailed manually watching videos one by one to ensure these factors were correct.

Data Collection

An Institutional Review Board process was completed and approved by the host institution. For students who agreed to participate via the consent form, grades from all assignments in the course were collected. These grades were stored on a secure Microsoft OneDrive. It is important to note that the numbers in the results section only represent the number of students who agreed that their data should be collected as approved by the IRB process. A simple Python program was implemented and utilized to parse through the data sets, calculate the median and interquartile range, perform data analysis, and generate the plots viewable in the findings subsection.

Results

Findings

Course A Findings

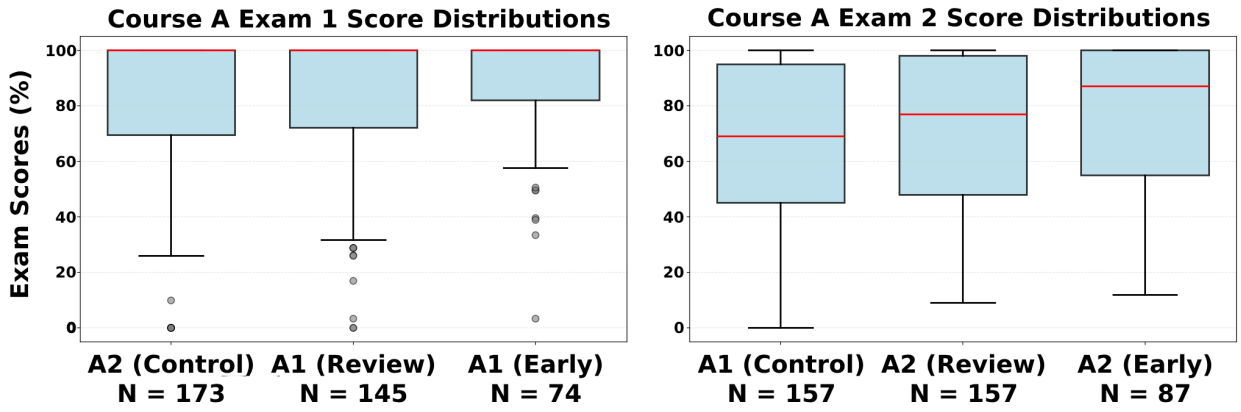

Figure 2: Score distributions for Course A Exam 1 (left), where Group A1 created review videos, and Exam 2 (right), where Group A2 created review videos. Red lines indicate medians and boxes show interquartile ranges.

Table 1: Descriptive Statistics for Course A, Exam 1

Group	N	Median %	Interquartile Range %
Group A2 (Control Group)	173	100.00	30.60
Group A1 (Review Group)	145	100.00	27.90
Group A1 (Only Submissions Prior to 9 PM)	74	100.00	18.00

From Course A, Exam 1's results in Table 1, an anomaly is visualized on the left side of Figure 2. Medians for all groups were 100%. The interquartile ranges decreased in the order of the control, review, and early submission groups at 30.6%, 27.9%, and 18%, respectively. The scores shown in Figure 2 and Table 1 include scores for all students who agreed for their data to be used in the study (N=318). The results show a median score of 100% which reflects that many students scored a perfect score on this exam.

Table 2: Descriptive Statistics for Course A, Exam 2

Group	N	Median %	Interquartile Range %
Group A1 (Control)	157	69.00	50.00
Group A2 (Review)	157	77.00	50.00
Group A2 (Only Submissions Prior to 9 PM)	87	87.00	45.00

Course A, Exam 2's results are shown in Table 2 and the right of Figure 2. The control group (A1) had the lowest median score (69%) followed by the review group (A2, 77%), and review group only considering submissions before 9 PM the day prior to the exam (87%). Interquartile ranges were the same for both groups at 50%, but only 45% for the early submission group.

Course B Findings

Table 3: Course B Pre-Test Results by Student Group

Group Measured	n	μ (%)	σ
Group B1	59	24.50	17.93
Group B2	39	26.58	19.37

Based on Table 3, it is possible to observe that during the pre-test, students randomly put into group B1 average 24.50 percent on the assessment whereas students randomly put into group B2 scored slightly higher with an average of 26.58 percent. There are high standard deviations at 17.93 percent and 19.37 percent for Group B1 and Group B2, respectively.

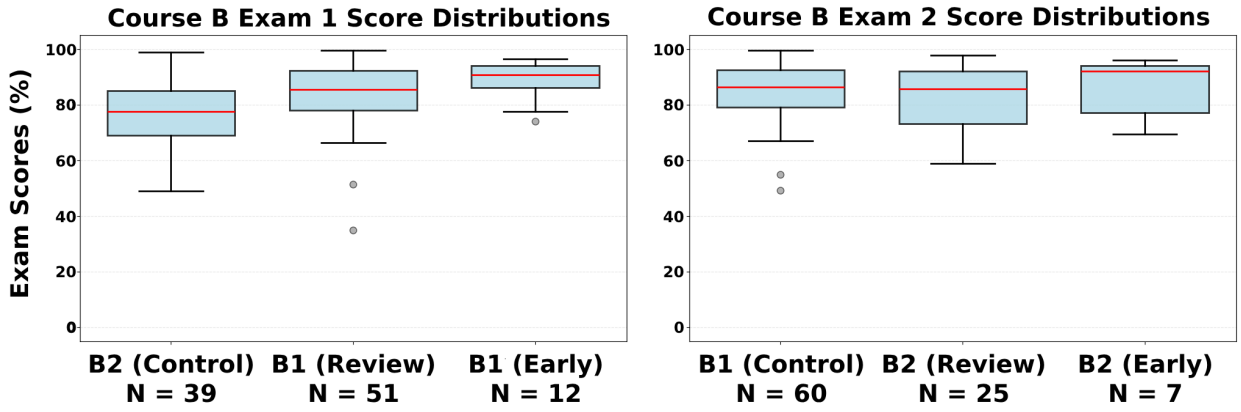

Figure 3: Score distributions for Course B Exam 1 (left), where Group B1 created review videos, and Exam 2 (right), where Group B2 created review videos. Red lines indicate medians and boxes show interquartile ranges. These score distributions include scores for all students who agreed for their data to be used in the study.

Table 4: Descriptive Statistics for Course B, Exam 1

Group	N	Median %	IQR %
B2 (Control)	39	77.50	16.00
B1 (Review)	51	85.50	14.25
B1 (Only Submissions Prior to 9 PM)	12	90.75	7.88

Course B, Exam 1's results are shown in Table 2 and the left of Figure 2. The control group (B2) had the lowest median score (77.50%) followed by the review group (B1, 85.5%), and then the

review group only considering submissions before 9 PM the day prior to the exam (90.75%). Interquartile ranges decreased for the control, review, and early submission groups at 16%, 14.25%, and 7.88%, respectively.

Table 5: Descriptive Statistics for Course B, Exam 2

Group	N	Median %	Interquartile Range %
B1 (Control)	60	86.34	13.37
B2 (Review)	25	85.66	18.83
B2 (Only Submissions Prior to 9 PM)	7	92.00	16.83

Course B, Exam 2's results are shown in Table 2 and the right of Figure 2. The review group (B2) had the lowest median score (85.66%) followed by the control group (B1, 86.34%), and then the review group only considering submissions before 9 PM the day prior to the exam (92.00%). Interquartile Range decreased for the review, early submission, and control groups at 18.83%, 16.83%, and 13.37%, respectively.

Data Analysis

To compare group results, we will use a Mann Whitney U test. We chose a non-parametric test because the data was not approximately normal. We specifically chose the Mann Whitney U to compare each exam's randomized, independent groups.

Course A Analysis

Table 6: Mann-Whitney U Test Results for Course A, Exam 1

Groups Compared	U	p-value	Effect Size (r)
Group A1 (Review) vs Group A2 (Control)	12857.50	0.6725	0.024
Group A1 (Prior to 9 PM) vs Group A1 (After 9 PM)	**3957.00**	**0.0008**	**0.268**
Group A1 (Prior to 9 PM) vs Group A2 (Control)	7182.00	0.0926	0.107

Table 6 shows the Mann-Whitney U Test results for Course A, Exam 1. It shows a significant difference between those in the review group who submitted before 9 PM the day prior to the exam and those who submitted after 9 PM ($p = 0.0008$). However, the difference between the review and control group ($p = 0.6725$) as well as the difference between those in the review group who submitted early compared to the control group ($p = 0.0926$) are considered insignificant differences.

Table 7: Mann-Whitney U Test Results for Course A, Exam 2

Groups Compared	U	p-value	Effect Size (r)
Group A2 (Review) vs Group A1 (Control)	11253.00	0.1810	0.075
Group A2 (Prior to 9 PM) vs Group A2 (After 9 PM)	**5289.50**	**0.000002**	**0.359**
Group A2 (Prior to 9 PM) vs Group A1 (Control)	**8378.00**	**0.0032**	**0.189**

Table 7 shows the Mann-Whitney U Test results for Course A, Exam 2. It shows a significant difference between those in the review group who submitted before 9 PM the day prior to the exam and those who submitted after 9 PM (p = 0.000002) as well as those in the review group who submitted early compared to the control group (p = 0.0032). There is once again an insignificant difference between the whole review group compared to the control group (p = 0.1810).

Course B Analysis

Table 8: Mann-Whitney U Test Results for Course B, Exam 1

Groups Compared	U	p-value	Effect Size (r)
Group B1 (Review) vs Group B2 (Control)	**1329.00**	**0.0065**	**0.287**
Group B1 (Prior to 9 PM) vs Group B1 (After 9 PM)	**400.00**	**0.0392**	**0.266**
Group B1 (Prior to 9 PM) vs Group B2 (Control)	**365.50**	**0.0036**	**0.407**

Table 8 shows the Mann-Whitney U Test results for Course B, Exam 1. The table shows a significant difference when comparing the review group to the control group (p = 0.0065), early submissions in the review group to late submissions in the review group (p = 0.0392), and when comparing those in the review group who submitted early to the control group (p = 0.0036).

Table 9: Mann-Whitney U Test Results for Course B, Exam 2

Groups Compared	U	p-value	Effect Size (r)
Group B2 (Review) vs Group B1 (Control)	818.50	0.5119	0.071
Group B2 (Prior to 9 PM) vs Group B2 (After 9 PM)	141.50	0.2885	0.170
Group B2 (Prior to 9 PM) vs Group B1 (Control)	226.00	0.7507	0.039

Table 8 shows the Mann-Whitney U Test results for Course B, Exam 2. The table shows no significant difference when comparing the review group to the control group (p = 0.5119), early submissions in the review group to late submissions in the review group (p = 0.2885), and when comparing those in the review group who submitted early to the control group (p = 0.7507).

Finally, a Shapiro-Wilk test was ran and determined the pre-test distribution described in Table 3 to be non-parametric. A Mann Whitney U-Test confirmed there was no significant difference in scores between Course B's groups 1 and 2 (p = 0.6462).

Discussion

Course A (Mandatory SCRV)

An unexpected outcome was that for Course A, Exam 1, Table 1 shows that for all groups, the median score was 100%. One likely explanation was that Course A was undergoing an experimental form of exam in which students were given five programming questions to code and compile during the allotted time. By completing all five questions, the students received a 100%

on the exam that they would know before leaving, creating an extremely skewed distribution. To clarify, an exam with a small number of questions led to a high number of students scoring perfect scores, hence why the median was a perfect score. We did not see this issue with the second exam as shown in Table 2 which could have been due to a more refined set of questions based on student feedback and data given it was the second iteration of this exam format.

Course A did not have significant differences in scores between the review and control groups for both exams, as shown in Table 6 and 7. Several factors could have influenced these outcomes, for example, students studying in ways other than SCRVs or the experimental exam design. However, one major aspect of Course A was that students were required to make an SCRV for their assigned exam no matter what, otherwise they were told they would not be admitted to the exams. Previously a study by Kusurkar et al. concluded that self-motivation is an important factor in academic success and performance [18], and thus we believe that the lack of intrinsic motivation in this assignment (i.e. students being forced) may have caused much lower effort and thus limited results.

Course A did, however, show a significant difference between those in the review groups who submitted before and after 9 PM, as shown in Tables 6 and 7. Furthermore, both exams had a much greater median score for student who submitted early compared to the control group, with a significant result observed during Exam 2. This shows that students who submitted earlier on average performed higher, which agrees with the prior research that not procrastinating can lead to higher academic performance [15].

Most importantly, this shows that although the review group did not in itself perform higher than the control group, students who submitted on a review prior to 9 PM the night before the exam did have significant improvement on exams. This could once again be tied to self-motivation, as students who chose to complete the assignment well before the deadline scored higher on exams.

Course B (Optional SCRV)

Another unexpected outcome occurred in Course B, Exam 2. We observed a lower median score for the review group than the control group as shown in Table 5 which lead to no significant results shown in Table 9. The likely answer to this phenomenon lies in the number of participants. Because participation was for extra credit for Course B, there was no way to guarantee students who signed up to participate would. During the second exam, only 25 students participated in the review group. It is plausible that students whose grades were high enough before exam 2 for the extra credit to not make a difference decided not to participate, leaving only those with lower overall course grades. Those with overall lower course grades would also be likely to score lower on an exam, thus making an impact on the exam 2 results.

The first exam for Course B had many more participants - likely because grades were not so set in stone yet so students who signed up were more likely to follow through. From Table 4 we observe the review group had an 8% increase in exam scores compared to the control. Table 8 also shows this to be a significant difference. Because participation in Course B was optional, we cannot say the review *caused* higher scores, however we can say that choosing to create a review *correlated* with higher exam performance. Furthermore, this reinforces the prediction made from Course A

that there was a larger difference when self-motivation was in play. Given students only received extra credit for participating, and had options to get that credit outside of this study, this means only students who truly wanted to participate did so - and here we see significantly higher scores.

It is important to note that the students were only being compared to other students who also signed up to participate, meaning this increase in scores could not be attributed to students who agreed to participate simply being better students. Furthermore, those who participated all did a pre-test prior to the course with results shown in Table 3, and neither group scored significantly higher than the other, so this change cannot be attributed to one group having more prior knowledge than the other.

Unsurprisingly, Table 8 also shows significant results in both the control group and early submissions review group and, similar to Course A, between the submissions before and after 9 PM the day before the exam. This once again confirms there is a noticeable difference between students who procrastinate until the night before and those who don't - most specifically we observed that students who turned in the assignment early on average performed better than not only the control group but also students who completed the review but submitted close to the exam time.

Limitations

While many standards were considered to make the experiment as significant and legitimate as possible, no experiment is ever perfect. We have identified two areas of caution within this experiment.

Incomplete Submissions

Of course, no matter how much it was stressed to complete the assignment, some students still did not complete the assignment properly. Whether this was in the form of making an irrelevant video, or a student simply not wanting to do the work, it happens. Furthermore, students who did not fill out the consent form did not have their data collected. Students with incomplete submissions or without consent explicitly given were not considered in this study. We are unsure how much the inclusion of these students would impact the results. The number of students who refused to participate was very small in comparison of the entire population though so one can expect the results in this study to still be fairly accurate. This issue was more prevalent in course B, where submissions were only for extra credit and not required. As previously discussed, this is a likely cause for Course B, Exam 2 to have the opposite of the expected results.

Submitting Early / Late Not Controlled

Submission time was not something separated before. It was observed after the experiment. Therefore, despite significant results, we cannot claim causation. There are likely other factors that cause students who submit early to do better and students who submit late to do worse - for example differences in self-regulation, motivation, and study habits. Therefore, this experiment cannot directly say turning in late leads to lower scores.

Future Work

Different Courses in Computing and Engineering

This experiment was done in two early computing courses. However, we wonder if the same results would present themselves in higher-level undergraduate computing courses and also in graduate computing courses. Furthermore, we wonder if similar results would present themselves in other engineering fields as a whole so that it could be generalized to all of engineering education.

Other Forms of Peer Teaching

This experiment focused on peer teaching via SCRVs. However, other forms of peer teaching exist such as older students teaching lessons to younger students [19] and we wonder if similar results would be observed.

Conclusion

To answer **RQ1: "What impacts, if any, does peer teaching via students creating SCRVs have on exam scores in early computing courses?"**, we can answer that on average, students in computing courses who create SCRVs do score higher than those who do not. However, the increase is only significant when student's choose to participate. We see this by students in Course B who were only offered extra credit having an increase in scores while student's in Course A who were required to participate lacked a significant difference in exam scores.

To answer **RQ2: "What is the difference, if any, between students who submit their assignment close to the deadline and those who submit earlier?"**, we can confidently say there is some correlation between students submitting earlier and higher scores, and students who submit later and lower scores. The reasoning for this is still yet to be established - but some predictions are that students who submit early are more self-regulated and have better study habits while the opposite is true for those who submit later.

Based on the results from these questions, we recommend that course instructors of early computing courses consider the addition of an extra credit assignment where students can create small review videos on relevant topics for upcoming exams. One potential implementation for this would be creating a discussion board where students could post links to their exam reviews, that way other students could also benefit from watching and reviewing content with a disclaimer that the videos are student-made and thus could have inaccuracies. With this is mind, instructors should make the exam SCRVs optional (self-motivated) and encourage students who create them to put the required time and effort in if they wish to see the best results. Furthermore, students should not procrastinate and complete the reviews late the night prior to the exam, otherwise they will likely see diminishing returns and in some cases worse performance.

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