The Effect of Self-Video Task on Students Conceptual Understanding of a Function and Its Derivative

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Abstract. This study examines the impact of student self-video on the attainment of conceptual understanding of function. A total of 40 Mathematics Education students at Universitas Muhammadiyah Sumatera Utara participated in the study. Half of the participants were taught with regular practical teaching, whilst the other half supplemented the teaching with a self-video task aimed at promoting reflection on performance. Students' conceptual understanding was measured in an objective structured examination. Students received significantly higher scores in the examination when the teaching had been supplemented with a self-video task.

INTRODUCTION

Online learning technology has driven continuous improvement in teaching in various fields, including calculus [1]. This started with the realization that although many college students are able to solve calculus problems procedurally, it is undeniable that many of them complete this course leaving significant misunderstandings about the basic concepts and an inability to apply what they have learned in real life. non-routine problems in the real world [2,3,4]. However, the low mastery of the concept of calculus is still an unsolved problem [5,6]. In addition, the use of online learning technology raises new challenges in the assignment and assessment of student learning outcomes, namely academic dishonesty and the weak commitment of students to submit their work [7]. For this reason, improvement efforts need to be based on understanding and examining the way students think and how they build calculus knowledge.

In particular, experience in online teaching shows that although the Learning Management System (LMS) available at Universitas Muhammadiyah Sumatera Utara – UMSU (https://elearning.umsu.ac.id/) facilitates online assignments and assessments, which provides students with feedback about whether their answers were right or wrong, the system did not provide feedback on how students think and construct knowledge. This becomes more problematic for online learning in asynchronous mode, where there is not enough space for lecturers to ask students for explanations regarding their work. As a result, the lecturer will only provide an assessment based on procedural problem-solving stages. If this happens, all the rationale that is used as a rational use of online learning to support students' understanding of concepts will fail. Thus, because there are not many online learning studies that use assessments of how students think and construct calculus knowledge, this study is important to carry out.

Apart from efforts to improve calculus learning involving online learning, there are few studies have been carried out on supporting students' understanding of calculus concepts through online learning activities by assessing the way students think and build calculus knowledge. Kattayat & Josey [8] investigates the understanding of students' calculus concepts through online learning in which learning activities are organized by referring to the syntax of a problem-based learning model. Students were given problems to solve collaboratively in groups and assessments were made using derivative of a function calculator software with online feedback. One of their important results was that the increased motivation and collaboration of students is influenced by assignments and assessments accompanied by online feedback. In addition, the increase in students' understanding of calculus concepts is significantly influenced by problem-based learning activities that are applied online.

The aspect of conceptual understanding that was not discussed by the above research is the ability of students to explain in writing and orally about how they solve the given problem. In fact, students who fully understand calculus content are students who not only master procedural skills, but also conceptual understanding [9] and it can be measured through students' ability to explain orally [10]. In this study, the effectiveness of online learning that combines aspects of oral and written assignments will be tested, namely videos made by students that focus on their explanation of problem solving and the concept of a function and its derivatives, on students' conceptual understanding.

METHOD

The design of this study was a single-center randomized controlled trial of educational teaching methods. Randomization was stratified by students' previous calculus conceptual understanding as measured via the preceding scores obtained from an objective structured examination, Calculus Concept Inventory (CCI) [11].

Participants

A total of 40 third-year students of the Mathematics Education Study Program at the UMSU were eligible to take part in the study. Participants' anonymity was ensured by blinding examiners to group allocation and by identifying participants prior to statistical analysis and subsequent reporting. In recruiting, an email containing an explanatory statement and consent form was sent to all students in bulk from the LMS. All students can access scores from the CCI and an anonymous questionnaire about their experiences during the study. All students also have a digital camera integrated into their cellphone as the equipment to capture digital video for the electronic submission of problem-solving activities.

Procedure

The task given to students was solving contextual problem of functions and its derivatives designed to acquire conceptual understanding skills from the student. Self-videos of problem-solving and written answers of student submissions were uploaded to the LMS, where they were reviewed by the lecturer and provided with group feedback. Students were asked to compare their own problem-solving with one of their peers chosen by the lecturer. Through these activities, students reflect on their strengths and weaknesses for their improvement.

Before the CCI was administered, the students were randomly allocated into two groups using a random number generator. The intervention group (50%) was given a self-made video task while the control group (the remaining 50%) completed the task in a paper-based manner. Both groups participated in CCI. During these activities, students were blind to the study intentions.

To minimize the impact of variations in expectations, examiners were blinded to the allocated group of participants. On completion of the CCI, examiners provide students with quantitative and qualitative formative feedback on their performance.

Data Analysis

Using the skewness test ($p = 0.70$), examiners' scores for the intervention and control groups were checked for normality before being compared for their CCI performance. A two-sample t-test with equal variances was administered to test the confidence in rejecting the null hypothesis being that the teaching method with self-video task administered to the intervention group did not enhance conceptual understanding of a function and its derivative for the third-year Mathematics Education students of 2021.

RESULTS

All students agreed to participate in the learning activities, where out of 40 students there were 2 people who did not attend the CCI session as presented in Figure 1.

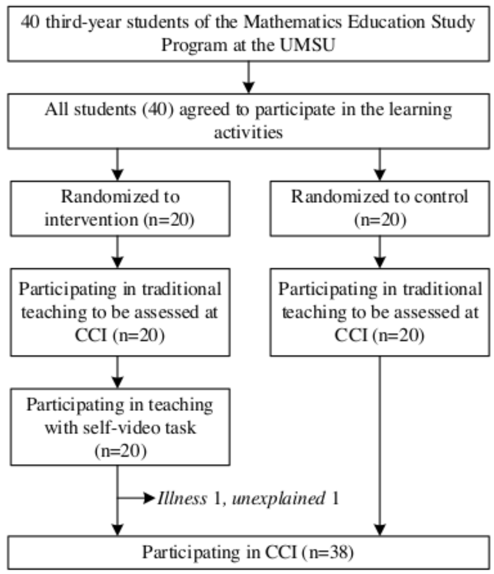

FIGURE 1. Flow-chart of student participation and data collection

From the results of data analysis, it was found that the mean (SD) of the intervention group was 21.12 (4.24) and the control group was 18.76 (3.85) with p = 0.046. It can be seen that the mean scores for understanding the concept of functions and its derivatives were significantly higher for the intervention group (who received instruction with self- video tasks) than for the control group (who received teaching with paper-based assignments). This difference in group mean corresponds to a 7.4% increase in scores for the CCI exam. The alternative CCI skill outcomes did not return a significant difference in group outcomes where the mean (SD) of the intervention group was 17.23 (6.25) and the control group was 19.67 (4.38) with p = 0.083.

DISCUSSION

Regular teaching supplemented with student self-video task encourages greater skill acquisition than regular teaching alone. The results are consistent with the study analyzing students self-regulated learning that significantly has higher level in creating problem-solving videos than in completing traditional written task [12].

Students' self-videos of conceptual understanding performance of a function and its derivatives were used in our study as a supplement to regular teaching rather than being an alternative teaching method. This may have increased student understanding and motivation as seen in previous studies reporting that student-authored video resulting in focus for their ideas and increasing motivation to learn more about their content [13].

This study was conducted in a web-based learning environment. In this setting, the delivery of educational content provides flexibility of access and promotes a student-centered approach [14]. Furthermore, increased student access to multimedia in a web-based learning creates opportunities for facilitating student reflection on their performance [15] and it has been proven in previous study that student reflection supports conceptual knowledge in mathematics [16].

The inability to measure the contribution of each component of the production process in producing a significantly improved understanding of the concept of functions and its derivatives is one of the limitations of this study. Future research could explore the impact of each of these components.

CONCLUSION

Student self-video task on solving contextual problems, facilitated by online lecturer feedback and student reflections, and delivered in a web-based learning environment, are a suitable teaching method to increase students' capacity in understanding the concept of functions and its derivatives.

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