

The Impact of Educational Videos on Student Learning in Online Mathematics Courses

Oscar Villalobos

Learning Technologies, University of North Texas

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Yunjo An, Ph.D.

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Introduction

The use of educational videos in mathematics courses has gained significant attention in recent years as the transition has slowly, but consistently been made into online courses. As digital learning environments become more dominant, understanding the impact of these videos on students' learning outcomes, motivation, and engagement is crucial. Educational videos, specifically in mathematics, offer a range of benefits. Such benefits include increased engagement, motivation, and improved understanding of complex concepts which can be complicated with options such as reading to learn mathematics. This literature review synthesizes our current findings from recent studies to explore the effectiveness of educational videos in mathematics education, highlighting some common themes, current trends, and notable gaps in the literature.

Body

Effectiveness of Educational Videos

Educational mathematics videos have been shown to significantly enhance learning outcomes, specifically in learners requiring complex problem-solving skills such as mathematics. Ding et. al (2022) conducted a quasi-experimental study with Dutch students learning Business Statistics and found that those who used short instructional videos outperformed their peers who followed traditional virtual lectures. This finding is consistent with Myllykoski's (2016) research on remedial mathematics instruction, which demonstrated that educational videos enrich the learning experience by increasing student engagement and understanding. Furthermore, Sen (2022) also noted a significant effect on test scores of the motivation for students using Khan Academy Videos.

Design and Implementation of Videos

The design and implementation of educational videos are important factors influencing their effectiveness when done correctly as opposed to just displaying videos on any Learning Management System (LMS). Rudloff and Erez (2021) emphasized the importance of catering to visual and auditory senses to enhance content retention and processing – keeping these senses from avoiding cognitive overload through design implementation plays a role in student learning. Similarly to the section prior this aligns with the findings of Sen (2022), who reported that Khan Academy Videos significantly improved student motivation and preparation processes for mathematics courses when looking at their tests, both pre-tests and post-tests analysis. This design and implementation can also be seen with Faye (2024) where videos alone didn't achieve the goal, but specifically in the method videos were presented – where students preferred videos created by their lecturers as opposed to other content creators.

Engagement

Student perception and engagement also play an important role in the effectiveness of educational videos in an online math course. Faye (2014) examined the use of self-made YouTube videos by their respective lecturers in teaching math and found that students preferred these videos over those found online by other content creators – creating a personalization principle as seen through Mayer's Principles of Multimedia Learning. Also, shorter videos of less than 15 minutes were found to be more effective as mentioned by Kinnari-Korpela (2015) and Ding et al. (2022). Kinnari-Korpela observed that short video lectures increased motivation and learning among engineering students taking calculus courses.

Cognitive Load

The impact of educational videos on cognition related to mathematics learning is another area of interest. Amalric et al. (2023) found that while short educational videos engage math-responsive brain networks transiently, they do not induce lasting changes. This suggests that videos alone may not be sufficient for deep learning and long-term retention since they may work in let us say one semester but may not have lasting effects on ongoing learners in an academic program. Also, as previously seen by Sen (2022), the article highlighted that although educational math videos can significantly enhance student motivation and course preparation, they may also contribute to cognitive overload if not designed properly. Meaning, that student learners using Khan Academy Videos showed increased motivation in the beginning, but without interactive elements and sufficient cognitive breaks the long-term retention of the material was limited.

Flipped Classroom

The flipped classroom model as studied by one of our classmates, Jose Gamez, which incorporates pre-class instructional math videos, has been shown to enhance in-class learning experiences and student success. Lo et al. (2017) conducted an analysis and synthesis of research on flipped classrooms in math education. They went on to demonstrate significant benefits in terms of increased in-class time for practice and real-time feedback as the students were able to learn (watch the videos) from the comfort of their homes, outside the classroom. Although this is seen with face-to-face courses it can also be applied to synchronous online math courses as well. Similarly, Huang et al. (2020) highlighted the positive impact of video creation activities, which improve mathematics achievement and student engagement by allowing students to actively

participate in creating tutorial videos as it allows them to be creative in their terms, but while having some type of foundation for them as guidance through the course.

Gaps in the Literature

Despite the positive findings, there are notable gaps in the literature. Firstly, there is a lack of long-term studies on the effectiveness of educational videos, with most research focusing on short-term outcomes (Amalric et al., 2023; Ding et al., 2022). This is mentioned because we want to know what happens to these student learners after they have left the classroom in question – does the success of these implementations carry on with them in their other math courses, STEM courses, or any courses they take – regardless of the modality? Second, the implementation of these videos with other teaching methods is also not well-studied (Rudloff & Erez, 2021). For example, Mayer's principles of multimedia learning suggest that videos should be combined with narration and on-screen text to reduce cognitive overload and enhance understanding. Additionally, Actor-Network Theory (ANT) could be applied to explore the dynamics between student learners, the educator(s), videos, and other educational tools. This emphasizes the network of relationships that contribute to learning outcomes. Moreover, principles of message design, such as segmenting content into manageable chunks and using signaling to highlight key information, could be crucial in creating effective educational videos. Gaps highlight how we should examine how these videos can complement traditional lectures, interactive problem-solving in-class sessions, and collaborative learning activities among learners to maximize their educational impact. Last, but not least, there is limited research comparing the impact of different types of video content, such as self-made versus professionally produced videos (Faye, 2014). The gaps tell us that if videos using screen recording with a stylus and digital notepad, like OneNote, think Khan Academy, have

the same impact as other videos with the same goal, but with a much higher production value in their video making.

Future Research

To address the gaps, we found I believe future research should consider the following:

- Conduct longer studies to review the long-term impact of educational videos on learning outcomes. (Amalric et al., 2023; Ding et al., 2022).
- Explore the effectiveness of different types of video content and their integration with traditional teaching methods. (Rudloff & Erez, 2021; Faye, 2014).
- Investigate the role of interactive elements (Quizlet and Kahoot) and immediate student feedback through surveys in enhancing the effectiveness of educational math videos. (Huang et al., 2020; Sen, 2022).

Summary

In conclusion, educational mathematics videos are highly effective in enhancing student engagement, student motivation, and student learning outcomes in online courses. Short, interactive, and self-made videos are particularly the most beneficial. However, to fully understand the long-term benefits of educational math videos there needs to be more thorough studies to consider. Also, further research should be done on how these videos can be integrated with traditional teaching methods and different types of video content are required. Therefore, by addressing these mentioned gaps in our literature review we can improve the student learning experiences and student learning outcomes in online mathematics courses through well designed educational videos.

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