

Educational YouTube Use: Associations with Mathematical Understanding and Learning Autonomy

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Abstract: The use of digital learning resources has become increasingly relevant in mathematics education, particularly through educational YouTube content that offers flexible and visual learning support. However, its relationship with students' mathematical conceptual understanding and learning autonomy still requires further empirical examination. This study aimed to analyze the relationship between the use of educational YouTube content and junior high school students' mathematical conceptual understanding and learning autonomy. A quantitative approach with a correlational design was employed. The participants were 30 seventh-grade students of SMP IT Nurul Fadhillah, selected through simple random sampling from a population of 88 students. Data were collected using a Likert-scale questionnaire to measure the use of educational YouTube content and learning autonomy, and a written test to measure mathematical conceptual understanding. The data were analyzed using descriptive statistics, prerequisite tests, and Pearson product-moment correlation with the assistance of IBM SPSS Statistics. The results showed that the use of educational YouTube content had a positive and significant relationship with students' learning autonomy ($R = 0.385$; $p = 0.039$), but it was not significantly related to mathematical conceptual understanding ($R = 0.276$; $p = 0.148$). These findings indicate that educational YouTube content is more closely associated with students' autonomous learning behavior than with their direct conceptual understanding in mathematics.

Keywords: educational YouTube content, learning autonomy, mathematical conceptual understanding junior high school students

INTRODUCTION

The development of information and communication technologies has profoundly transformed the world of education, requiring adaptation to digital pedagogical innovations. The YouTube platform, initially conceived as a simple entertainment medium, offers considerable potential for learning mathematics. It has become a rich educational resource in terms of visuals and interactivity. The use of educational content on YouTube allows for more concrete, flexible, and independently accessible presentations, which can increase student motivation and engagement in understanding abstract concepts (Sen, 2022; Akorede et al., 2024). Theoretically, educational videos on YouTube promote the integration of visual and verbal information, thus facilitating cognitive understanding. They align with the principle of self-regulated learning, which emphasizes students' ability to organize, monitor, and evaluate their own learning without relying entirely on teachers (Tumana & Ucang, 2023).

Although the potential of this digital medium is widely recognized, the reality on the ground reveals a gap between students' expectations and the current situation. According to initial observations conducted with seventh-grade students at the SMP IT Nurul Fadhillah middle school, their understanding of abstract mathematical concepts, such as scales, remains insufficient. Students tend to memorize definitions without grasping their practical meaning and struggle to

connect the notion of scale to other concepts, such as proportion. This situation is exacerbated by a low level of autonomy in learning: students remain highly dependent on teacher guidance, lack initiative in seeking additional learning resources, and are not very active in evaluating their own learning. This low level of conceptual understanding and autonomy constitutes a major obstacle to achieving the learning objectives in mathematics (Kirana et al., 2022; (Adelina et al., 2023).

Several previous studies have examined the role of digital media in mathematics education, but their findings vary in approach and methods. Zaid, (2024) research shows that students' use of YouTube and their self-confidence are partially related to their ability to solve mathematical problems, although this relationship is not significant when analyzed together. Meanwhile, the research of Arisa & Alfiah, (2025) and Ardiansyah dkk. (2024) ocused more on the development and validity of educational video products, demonstrating that YouTube educational videos constitute a valid, practical, and effective teaching tool. For his part, Ramadhani (2024) found that independent learning significantly influences the understanding of mathematical concepts, thus confirming that independent learners tend to grasp the subject matter better. However, most of these studies have used experimental protocols to measure effectiveness or causal influence and have tended to separate conceptual understanding and learning autonomy variables in their analyses.

Although previous studies have shown the potential of YouTube and digital media in mathematics learning, several limitations remain. First, many studies have examined YouTube mainly as an instructional intervention to improve learning outcomes, motivation, or problem-solving ability, rather than as a learning resource naturally used by students in relation to their conceptual understanding and learning autonomy. Second, studies that developed YouTube-based instructional videos generally focused on product validity, practicality, and effectiveness within structured learning settings. Such studies provide important evidence of media feasibility, but they do not fully explain whether students' use of educational YouTube content is directly associated with their mathematical conceptual understanding when the media are accessed more independently. Third, previous research on learning autonomy has often treated autonomy as a predictor of achievement or conceptual understanding, but has not sufficiently examined how the use of educational YouTube content relates to students' autonomous learning behavior. Therefore, there is still a need for correlational research that simultaneously investigates the relationship between educational YouTube use, mathematical conceptual understanding, and learning autonomy among junior high school students. This study addresses this gap by focusing not on the effectiveness of a particular video product or teaching intervention, but on the empirical association among these variables in the context of mathematics learning.

The novelty of this study lies in its simultaneous analysis of two important student-related variables, namely mathematical conceptual understanding and learning autonomy, in relation to the use of educational YouTube content. Unlike previous studies that generally examined YouTube as an instructional intervention, a developed learning product, or a medium for improving motivation and learning outcomes, this study focuses on the natural use of educational YouTube content by junior high school students. Furthermore, this study applies a correlational design to identify whether students' use of educational YouTube content is associated with their conceptual understanding and autonomous learning behavior. Thus, the study provides empirical evidence on the role of YouTube not as a direct teaching intervention, but as a digital learning resource that may relate differently to cognitive and self-regulated learning aspects in mathematics. Therefore, this study aims to fill this gap by simultaneously analyzing the relationship between the use of educational content on YouTube and the understanding of

mathematical concepts and the learning autonomy of middle school students, without evaluating effectiveness or causal influence, but rather focusing on the correlation between variables.

Given this context and this research gap, the main objective of this article is to determine whether there is a relationship between the use of educational content on YouTube and the understanding of mathematical concepts and the learning autonomy of middle school students. The results of this study should make an empirical contribution to the development of relevant mathematics learning strategies.

METHOD

This study used a quantitative approach with a correlational design to examine the relationships between variables. It was conducted at Nurul Fadhilah Islamic Middle School (SMP IT) in Deli Serdang, North Sumatra, during the even semester of the 2025 academic year. The study population consisted of 88 seventh-grade students. The sample was selected by simple random sampling, which yielded 30 students. This method was chosen because the population was relatively homogeneous and allowed for representative random sampling (Suriani & Jailani, 2023).

The research instruments were of two types: a questionnaire and a test. The variables "use of YouTube educational content" (X) and "learning autonomy" (Y2) were measured using a Likert-scale questionnaire covering indicators of usability, ease of use, student attitudes, initiative, discipline, and evaluation of the learning process. This instrument was adapted from previous research (Sugiharto et al., 2020; Faiza & Lestari, 2024; Rahayu & Aini, 2021). The variable of understanding mathematical concepts (Y1) was measured using a structured written test based on the following indicators: reformulation of concepts, provision of examples and counterexamples, presentation of mathematical representations, and application of concepts (NCTM, 2001). Before its use, the validity and reliability of the instrument were tested using IBM SPSS Statistics software. Validity was assessed by comparing the calculated correlation coefficient (r) with the tabulated r , while reliability was assessed using Cronbach's alpha coefficient, with a threshold of 0.60.

The research procedure consisted of three main steps: preparation, implementation, and data processing. During the preparation phase, the researcher developed the instrument, validated it, and determined the sample size. Implementation consisted of distributing the questionnaire and administering the test to the respondents. The final step was data processing for statistical analysis. The research workflow is shown in Figure 1.

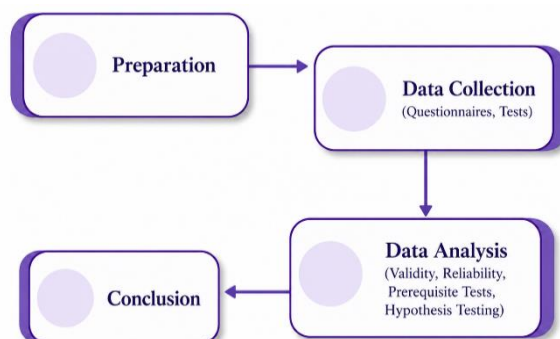


Figure 1. Research Flowchart

Data analysis was performed using IBM SPSS Statistics software. It included preliminary tests for normality and linearity to verify that the data met the parametric statistical assumptions.

The assumptions were tested using Pearson's correlation coefficient to determine the degree of relationship between variables, and by simple linear regression to predict the effect of the independent variables on the dependent variable. The significance level was set at 0.05. If the significance level is less than 0.05, the null hypothesis (H_0) is rejected, indicating a significant relationship. The criteria for interpreting correlation values are consistent with the general statistical recommendations of Sugiyono (2018), cited in (Kurniawan., H, 2021).

RESULTS AND DISCUSSION

This section presents the findings of the study based on the statistical analysis of the three research variables: the use of educational YouTube content, mathematical conceptual understanding, and learning autonomy. The results are organized into several parts, including descriptive data, instrument quality, prerequisite tests, and hypothesis testing. This structure is intended to provide a systematic explanation of the data before discussing the relationships among the variables.

Description of Data Relating to Instrument Quality

Before conducting inferential statistical analysis, descriptive statistics were first examined to provide an overview of the distribution of students' scores on each variable. Figure 2 presents the graphical distribution of the scores for the use of educational YouTube content, mathematical conceptual understanding, and learning autonomy. This visualization helps illustrate the general pattern of the data before the results are further analyzed using validity, reliability, prerequisite, and hypothesis testing.

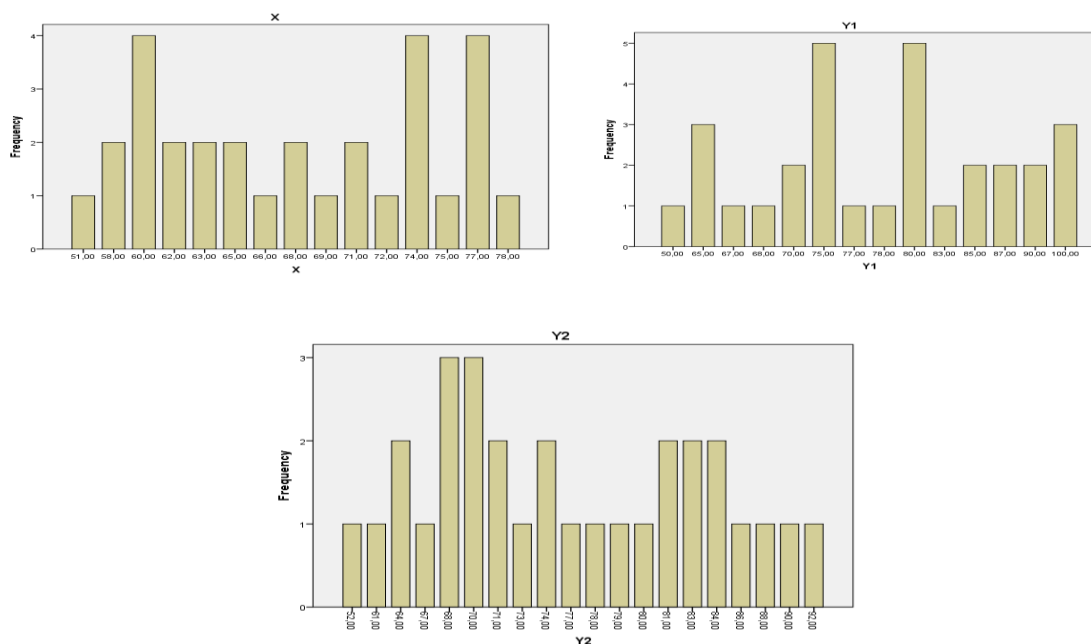


Figure 2. Graphical Description of the Research Data

Figure 2 presents the graphical distribution of students' scores for the three research variables. The first graph represents the use of educational YouTube content, with scores distributed within a moderate to high range. This indicates that most students had already used educational YouTube content as a supporting learning resource. The second graph shows the distribution of students' mathematical conceptual understanding scores, which generally appear in the good category, although some variation among students is still observed. The third graph

illustrates students' learning autonomy scores, showing that most students demonstrated a fairly good level of independent learning. Overall, Figure 2 indicates that the data for the three variables are distributed reasonably and can be further analyzed through prerequisite and hypothesis testing.

This research was conducted with 30 fifth-grade students from IT Nurul Fadhilah Middle School. The collected data were analyzed using descriptive statistics to characterize the variables studied. The average score for using educational YouTube content was 67.63 (standard deviation: 7.28), indicating a fairly high level of use, but with relatively low variation. The score for understanding mathematical concepts averaged 78.57 (standard deviation: 11.33), indicating that most students possessed a good understanding. Furthermore, the average score for independent learning was 75.03 (standard deviation: 9.31).

Before analyzing the hypotheses, the research instrument was validated and its reliability tested. This instrument, accessible on YouTube, has a Cronbach's alpha coefficient between 0.755 and 0.800. The mathematical concept comprehension test was also declared valid (item correlation coefficient greater than 0.546) and reliable (Cronbach's alpha = 0.632). The results of the validity and reliability tests ensure that the data used in the research are of sufficient quality for further analysis.

Prerequisite Test for Analysis

A prerequisite test for analysis was performed to verify that the data met the parametric statistical assumptions. The Kolmogorov-Smirnov normality test revealed a significance level of 0.200, greater than 0.05. This indicates that the data follow a normal distribution. Next, a linearity test was performed to determine the relationship between the variables. The results of this test showed a significant deviation from linearity of 0.266 for the relationship between YouTube and conceptual understanding, and 0.280 for the relationship with learning independence. Since both values are greater than 0.05, we can conclude that the relationship between the variables is linear.

Relationship Between the Use of Educational Content on Youtube and Understanding of Mathematical Concepts

A preliminary hypothesis test was conducted to determine the relationship between the use of educational content on YouTube and the understanding of mathematical concepts. The results of a simple linear regression analysis showed a correlation coefficient (R) of 0.276 with a significance level of 0.148. According to the interpretation criteria, the value of R (0.276) is considered a weak correlation. However, since the significance level (0.148) is greater than the threshold of 0.05, the hypothesis of a significant relationship is rejected. This means that, in this study, the use of educational content on YouTube is not significantly correlated with students' understanding of mathematical concepts.

This result suggests that, even if students access resources via YouTube, this does not automatically improve their understanding of mathematical concepts. This phenomenon can be explained by the theories of dual coding and self-regulated learning. In this context, students' independent use of YouTube, without systematic pedagogical guidance, can lead to passive viewing without in-depth information processing.

This finding aligns with Zaid (2024) research, which established a partial link between YouTube use and mathematical problem-solving skills, although this link was not statistically significant. This research highlights that the effectiveness of digital media depends heavily on factors internal to the students, such as self-confidence. In contrast to the work of Arisa & Alfiah, (2025) , which demonstrated the effectiveness of YouTube videos in improving conceptual understanding, this difference in results is likely due to factors related to the structure of the learning. In their study, the videos were used within a structured learning model (Borg & Gall

R&D), whereas in the present study, YouTube use was more of a spontaneous activity among the students. This indicates that digital media alone are insufficient to improve cognitive abilities without targeted learning strategies and pedagogical support.

Relationship Between the Use of Educational Content on Youtube and Self Directing Learning

The second hypothesis test aimed to determine the relationship between the use of educational content on YouTube and self-directed learning. The analysis revealed a correlation coefficient (R) of 0.385, with a significance level of 0.039. A significance level below 0.05 indicates that the hypothesis is accepted, namely that there is a positive and significant relationship between the use of educational content on YouTube and self-directed learning. The coefficient of determination (R^2) of 0.148 indicates that 14.8% of the variation in learning autonomy can be explained by the use of educational content on YouTube.

This result indicates that the intensity of YouTube use is correlated with students' ability to regulate their own learning process. This aligns with the characteristics of the YouTube platform, which offers flexible access, allowing students to review content, choose their study times, and access educational resources outside of class time. This condition fosters the development of self-regulated learning, where students have greater control over their learning strategies.

The results of this study corroborate the findings of Ramadhani (2024), who asserted that learning autonomy significantly influences the understanding of mathematical concepts. Although, in this study, YouTube did not directly influence conceptual understanding, it contributed to learning autonomy, which could theoretically be a factor promoting improved understanding. Furthermore, these results are consistent with those of Nadela & asyhar (2022), who found that using YouTube videos significantly influences learning motivation, an important component of independent learning. However, the relatively weak correlation (0.385) indicates that YouTube use is not the sole factor.

The results of this study show that the use of educational YouTube content does not have a significant relationship with students' mathematical conceptual understanding. Although the direction of the relationship is positive, the correlation value remains low and is not statistically significant. This finding indicates that students' access to learning videos on YouTube does not automatically lead to deep mathematical conceptual understanding. Mathematical conceptual understanding does not only require students to watch or listen to explanations, but also requires the ability to restate concepts, provide examples and non-examples, present concepts in various representations, and apply concepts in problem-solving. Therefore, students who watch instructional videos do not necessarily develop strong conceptual understanding if the activity is not accompanied by structured guidance, discussion, practice, and reflection.

This finding can be understood from the characteristics of YouTube as an open digital platform. YouTube provides easy access, visual explanations, and opportunities for students to repeat learning materials according to their needs. Sen (2022) and Akorede et al. (2024) explain that educational videos can increase student engagement and help present mathematics materials more visually. However, the benefits of instructional videos depend greatly on how the media are used in the learning process. If students only watch videos passively, the deeper thinking processes needed to understand mathematical concepts may not occur optimally. Thus, the results of this study emphasize that educational YouTube content is not sufficient as an independent learning resource without clear pedagogical guidance.

The results of this study are in line with the findings of Zaid (2024), which showed that the use of YouTube media and students' self-confidence had only a partial relationship with

mathematical problem-solving ability and did not provide a strong simultaneous contribution. This indicates that digital media are not the only factor determining success in mathematics learning. Other factors, such as students' prior knowledge, learning motivation, practice intensity, teachers' instructional strategies, and the quality of the content used, may also influence students' mathematical conceptual understanding. However, the findings of this study differ from those of Arisa and Alfiyah (2025) and Ardiansyah et al. (2024), who found that YouTube-based instructional videos could help improve students' mathematical conceptual understanding. This difference may be due to differences in research design and the context of media use. In previous studies, YouTube videos were used in more structured learning settings, whereas this study only examined the relationship between the use of educational YouTube content and students' conceptual understanding and learning autonomy through a correlational design.

In contrast to mathematical conceptual understanding, the use of educational YouTube content has a positive and significant relationship with students' learning autonomy. This finding indicates that YouTube is more closely related to students' independent learning behavior than to the direct improvement of cognitive understanding. The flexibility of YouTube allows students to choose the materials they want to learn, repeat explanations they do not yet understand, study outside school hours, and regulate their learning pace according to their individual abilities. These characteristics are closely related to learning autonomy, such as initiative, discipline, the ability to select learning strategies, and self-evaluation.

This finding is consistent with Tumana and Uchang (2023), who emphasize that self-regulated learning is related to students' ability to organize, monitor, and evaluate their own learning process. Rahayu and Aini (2021) also explain that learning autonomy in mathematics is reflected in students' initiative, responsibility, and ability to use relevant learning resources. In the context of this study, YouTube can serve as an alternative learning resource that provides students with opportunities to learn more independently, especially when they need additional explanations beyond classroom learning.

The positive relationship between YouTube use and learning autonomy is also supported by the study of Nadela and Asyhar (2022), which found that the use of YouTube videos could increase students' learning motivation and mathematics learning outcomes. Although learning motivation and learning autonomy are not the same variables, motivation is one of the important elements in the development of learning autonomy. Students who are interested in using digital learning resources tend to be more encouraged to seek information, repeat learning materials, and regulate their own learning process. In addition, Ramadhani (2024) found that learning autonomy plays an important role in mathematical conceptual understanding. Therefore, although YouTube use is not directly and significantly related to conceptual understanding in this study, YouTube may still have an indirect role through the strengthening of students' learning autonomy.

In general, the results of this study indicate that educational YouTube content has stronger potential in supporting self-regulation and learning autonomy than as a direct source for building mathematical conceptual understanding. YouTube can help students become more independent learners, but its effect on conceptual understanding will be more optimal if teachers integrate it into guided learning activities. Teachers can provide guiding questions before students watch videos, ask students to write summaries after watching, facilitate classroom discussions, and assign problem-solving tasks related to the video content. In this way, YouTube does not only function as a source of information, but also becomes part of an active learning strategy that can support both students' mathematical conceptual understanding and learning autonomy.

This study has several limitations. First, it used a correlational design; therefore, the findings cannot explain causal relationships between the use of educational YouTube content, mathematical conceptual understanding, and students' learning autonomy. Second, the sample was limited to 30 seventh-grade students from one school, so the findings cannot be widely generalized to all junior high school students. Third, data on YouTube use and learning autonomy were collected through questionnaires, which may be influenced by students' perceptions and response bias. Fourth, this study did not examine other factors that may affect conceptual understanding and learning autonomy, such as students' prior mathematical ability, learning motivation, digital literacy, teacher guidance, the quality of YouTube content, and students' practice intensity. As Zaid (2024) stated, YouTube use is not the only factor related to students' mathematical ability, since internal factors and instructional strategies also play an important role.

The findings imply that educational YouTube content is more strongly associated with students' learning autonomy than with their direct mathematical conceptual understanding. This is consistent with Tumana and Ucang (2023) and Rahayu and Aini (2021), who emphasized that learning autonomy is related to students' ability to regulate, monitor, and evaluate their own learning process. Practically, mathematics teachers need to integrate YouTube into guided learning activities. For example, teachers may provide guiding questions before students watch videos, ask students to write summaries, facilitate classroom discussions, and assign problem-solving tasks after watching. In this way, YouTube can function not only as an additional source of information but also as part of an active learning strategy that supports both students' learning autonomy and mathematical conceptual understanding. Sen (2022), Akorede et al. (2024), and Nadela and Asyhar (2022) also showed that instructional videos can improve engagement, motivation, and learning flexibility when they are used appropriately in the learning process.

CONCLUSIONS AND SUGGESTIONS

This study concludes that the use of educational content on YouTube has a positive and significant impact on students' autonomy in their learning, but not on their understanding of mathematical concepts. This result indicates that digital media are more effective in supporting self-regulated learning than as a source of direct transfer of cognitive knowledge. YouTube's effectiveness in fostering student autonomy is evident in its flexible access and students' ability to control their learning pace, while its limited impact on conceptual understanding is due to the lack of structured guidance in the use of this media.

Subsequently, teachers can integrate YouTube content into structured learning models, such as the flipped classroom or problem-based learning, to maximize cognitive impact. Students should be supported not only in viewing the content, but also in engaging in advanced cognitive activities, such as problem-solving and reflection. Future research is recommended to incorporate moderating variables, such as student motivation or teachers' pedagogical strategies, to obtain a more comprehensive view of the effectiveness of digital media in mathematics learning.

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