
RESEARCH ARTICLE

YouTube Videos as a Pedagogical Tool in Teaching Mathematics

Ebbah, Anarose G.¹✉, Castilla, Gretchen P.², Ares, Cecilia O³ Alcantara, Richard T.⁴ Sagayno, Renato C.

¹MST-Math, LPT., SHS Program Coordinator, University of Cebu, Cebu City, Philippines

²MST-Math, LPT., JHS Program Coordinator, University of Cebu, Cebu City, Philippines

³Ed.D., ELM, BSED Chairperson, University of Cebu, College of Teacher Education, Cebu City, Philippines

⁴Dev.Ed. D., Graduate School Faculty, University of Cebu City, Philippines

⁵Dev.Ed. D., Graduate School Program Research Coordinator, University of Cebu City, Philippines

Corresponding Author: Ebbah, Anarose G. **E-mail:** anaroseebbah@gmail.com ; Castilla, Gretchen P. **Email:**

blancocastilla.232017@gmail.com ; Ares, Cecilia O. **Email:** fractalsares09@gmail.com **Email:** Alcantara, Richard T. **Email:**

drrichardalcantara@gmail.com ; Sagayno, Renato C. **Email:** renatosagayno@gmail.com

ABSTRACT

In today's changing educational environment, incorporating multimedia materials such as YouTube is becoming increasingly crucial for enhancing learner interaction and understanding. This research examines the effectiveness of using YouTube videos in mathematics teaching for Grade 7 Junior High School students at the University of Cebu, Pardo and Talisay Campus, Bulacao, Cebu City, Philippines. The primary purpose is to determine whether multimedia can enhance learners' understanding and performance in mathematics. Using a quasi-experimental research design, the research involved sixty (60) Grade 7 students, divided equally into control and experimental groups. The researcher used a matched-pairs sampling technique, matching students by gender and second grade period mathematics grades to ensure group comparability. A researcher-made questionnaire was the primary tool for data collection, administered both as a pretest and a posttest. The researcher conducted data analysis using appropriate statistical methods, including frequency and percentage counts, mean, and standard deviation, and t-tests for independent and paired samples, with a significance level of 0.05. Results indicated that both groups performed equally poorly on the pretest, with no difference between them ($p = 0.263$), suggesting an equivalent baseline. Post-intervention scores indicated significant improvement in both groups ($p < 0.001$); however, the experimental group, which was instructed and supplemented with YouTube videos, performed better than the control group in the posttest ($p = 0.049$). These findings indicate that incorporating YouTube videos into mathematics instruction can significantly improve students' learning outcomes. Teachers should incorporate high-quality, relevant multimedia resources into their instructional practices to improve student engagement, retention, and academic achievement in mathematics.

KEYWORDS

YouTube videos, Mathematics instruction, Math Students, Educational Technology, Quasi-experimental study, Cebu City, Philippines.

ARTICLE INFORMATION

ACCEPTED: 01 February 2026

PUBLISHED: 22 February 2026

DOI: 10.32996/bjtep.2026.5.3.2

1. Introduction

Digital technology has revolutionized how education is delivered, with platforms like YouTube becoming vital tools for learning. YouTube, a globally accessible video-sharing platform, offers instructional videos that simplify complex subjects like mathematics. Mathematics, often perceived as a challenging subject by many junior high school students, encompasses abstract concepts like algebra and geometry that require innovative teaching methods to ensure understanding. Using YouTube videos as the medium of instruction provides an organized and engaging way to deliver lectures, allowing students to learn through visual

Copyright: © 2026 the Author(s). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) 4.0 license (<https://creativecommons.org/licenses/by/4.0/>). Published by Al-Kindi Centre for Research and Development, London, United Kingdom.

demonstrations and practical applications. This method changes the emphasis from traditional classroom education to a more interactive, technology-driven learning experience.

Globally, YouTube has become a cornerstone for online education. A 2024 Statista report highlights that over 46% of internet users aged 16–24 engage with educational content on YouTube, emphasizing its widespread adoption (Ceci, 2025). Additionally, a 2023 Pew Research study found that YouTube remains the most popular social media platform among teenagers, with 90% of them actively using it for various purposes, including education (Gottfried, 2023). These figures underscore the platform's potential to address educational challenges by providing accessible, engaging materials.

In Southeast Asia, the use of YouTube for education is steadily increasing, especially in countries such as Malaysia, Indonesia, and the Philippines. The Philippines has seen a surge in digital education initiatives, with YouTube, with a wide range of tutorials, playing a central role in delivering instructional content, allowing educators to supplement traditional teaching with engaging and accessible video lessons.

In the local context, a study conducted across three private high schools in Cebu found that the use of websites such as YouTube significantly influences students' achievement in mathematics. Furthermore, the results revealed that integrating teacher-created YouTube videos into lessons significantly improved students' mathematical performance. While studies in Cebu City are limited, the national trend indicates that YouTube-based mathematics learning has been effective.

Although studies have explored the role of YouTube in education, gaps remain regarding its specific impact on mathematics instruction. Most studies employed descriptive survey methods to examine students' attitudes, views, or self-reported experiences. Quasi-experimental studies comparing the academic achievement of students taught using YouTube videos with those instructed through traditional methods are limited. This methodological gap limits the evidence on whether YouTube videos truly improve student achievement in mathematics rather than merely supporting motivation or interest.

In the researcher's observations, many Grade 7 students face significant challenges in understanding mathematical concepts, particularly algebra and geometry. While effective for some, traditional teaching methods often fail to cater to diverse learning styles. Observations reveal that many students rely on YouTube Videos for additional support, finding the visual explanations helpful for grasping complex topics. However, there is no formal research to confirm whether this practice improves learning outcomes.

The study, YouTube videos as a pedagogical tool in teaching mathematics, aims to assess the effectiveness of using YouTube as a teaching tool for student learning. This quasi-experimental study will compare the influence of YouTube videos on student learning outcomes in Mathematics with that of traditional instruction. The researcher, as a Mathematics teacher, has the necessary qualifications to conduct the study, including knowledge of teaching, research design, and data analysis. The study's findings will help educators and policymakers improve mathematics instruction by advancing digital learning.

2. Framework

This study is anchored on Multimedia Learning Theory (2001) by Richard Mayer and supported by Cognitive Load Theory (1988) by John Sweller, and Constructivist Learning Theory (1964) initially proposed by John Piaget.

Multimedia Learning Theory Mayer (2001), suggests that presenting information through both visual and verbal channels improves learning effectiveness. According to Mayer, people learn better when multimedia, such as pictures and text, are combined in ways designed to enhance learning and reduce cognitive load. The theory emphasizes principles such as the dual-channel principle, which states that learners have separate channels for processing visual and verbal information, and the redundancy principle, which warns against overloading a single channel with redundant information. In the context of teaching mathematics through YouTube videos, these principles are particularly relevant. Visual demonstrations of mathematical problems, combined with spoken explanations, engage both the auditory and visual channels, facilitating more profound understanding and retention of information.

Multimedia Learning Theory explains that presenting information through both visuals and verbal channels helps students learn more effectively than relying solely on words, as in a lecture. It also emphasizes that the human brain processes information through distinct channels, which are auditory/verbal and visual/pictorial, each of which has a limited capacity. Effective learning happens when students actively select and organize meaningful structures and integrate them with their prior knowledge. This theory provides a strong foundation for creating engaging and effective educational content in classrooms and for making learning more meaningful for students.

Multimedia Learning Theory also highlights the importance of managing cognitive load to ensure effective learning, particularly in multimedia environments. By carefully designing tutorials that align with learners' cognitive structures, YouTube videos can present complex mathematical concepts in ways that minimize unnecessary cognitive load and maximize learning potential. For instance,

a well-structured tutorial might break down a complex equation step by step, using clear visuals and concise explanations that complement each other. It helps learners process information more efficiently, ensuring their cognitive resources are focused on understanding core mathematical concepts rather than struggling to follow a confusing or overloaded presentation. The use of YouTube videos in this study reflects this multimedia learning principles, offering an accessible and effective way to teach mathematics while adhering to Mayer's guidelines for optimizing cognitive processing.

Constructivist Learning Theory (1964) by Jean Piaget highlights that students connect knowledge through experience and interaction with the environment rather than simply receiving it from teachers. Piaget also emphasizes that students learn by interacting with their environment, exploring, asking questions, and solving problems. He emphasized active learning and hands-on experiences in education, giving students opportunities to explore and discover answers on their own rather than relying solely on teacher memorization. In addition, this theory explains that teachers act as facilitators of learning rather than providers of knowledge, activating students' curiosity and exploration and creating meaningful learning experiences.

Constructivist Learning Theory (1964), pioneered by Jean Piaget and later expanded by Lev Vygotsky, emphasizes that learning is an active, dynamic process where students build their understanding of the world. Piaget believed that learners actively engage with their environment, adapting their cognitive structures as they encounter new experiences. For Piaget, this learning process involves assimilation, in which new information is incorporated into existing knowledge, and accommodation, in which learners adjust their frameworks to accommodate new ideas. This process of learning through experience is central to how students engage with and make sense of the world around them (Vintere, 2018). For this study, YouTube videos align with constructivist principles by providing an interactive, dynamic tool that allows students to build their knowledge at their own pace. The videos present mathematical problems and solutions, encouraging students to develop their understanding as they observe various problem-solving strategies.

Constructivist Learning Theory contributions to constructivism further deepen the understanding of how social interactions influence learning. Vygotsky emphasized the importance of collaboration and social context in cognitive development, introducing the concept of the Zone of Proximal Development (ZPD). This idea highlights that learners can perform tasks beyond their current abilities with the proper guidance, whether from a teacher, a peer, or even a multimedia resource like YouTube. By using YouTube videos, students can engage with the material independently, while also benefiting from the social aspect of discussing and sharing their learning experiences. This blend of individual exploration and social interaction on online platforms supports Vygotsky's vision of a collaborative learning process, in which learners advance with appropriate guidance and shared knowledge.

Cognitive Load Theory, developed by John Sweller (1988), focuses on the capacity of working memory and how instructional design can be optimized to facilitate learning. Sweller identified three types of cognitive load: intrinsic, extraneous, and germane. Intrinsic load refers to the inherent complexity of the material, extraneous load arises from how the material is presented, and germane load is the mental effort students use to process the content meaningfully. The theory suggests that learning is most effective when the cognitive load is balanced, ensuring that students' working memory is not overloaded with unnecessary information (Gupta & Zheng, 2020). In this context, YouTube videos can effectively manage the cognitive load by presenting mathematical concepts in a visually engaging, step-by-step manner. This multimedia approach can reduce extraneous load, allowing students to focus their mental resources on understanding the core content, rather than being overwhelmed by complex textual explanations.

Cognitive Load Theory (1988) by John Sweller explains how the human brain processes and keeps information, particularly in the working memory, by balancing the three types of cognitive load. It will allow students to process information efficiently and transfer it to long-term memory without overwhelming them. Effective learning happens when the information is transferred from working memory to long-term memory. Cognitive load theory can serve as a cornerstone of instructional design, especially in fields that require mental effort and retention, such as mathematics.

Cognitive Load Theory suggests that using both visual and auditory channels for information presentation can enhance learning, as it taps into separate processing capacities of the brain. YouTube videos can provide learners with a multimodal experience that supports cognitive load management. By using animated graphics, voice explanations, and text annotations, YouTube videos allow students to process information through multiple cognitive pathways, thereby reducing strain on working memory. This multimodal approach helps students absorb mathematical concepts more effectively, ensuring that their cognitive resources are directed toward understanding rather than deciphering complex or poorly organized materials. In this study, YouTube videos serve as tools that not only make mathematical concepts more accessible but also optimize cognitive load during learning.

The 1987 Constitution of the Philippines, particularly Article XIV, Section 1, provides that " The state shall protect and promote the right of all citizens to quality education at all levels and shall take appropriate steps to make such education accessible to all" (Philippine constitution 1987). By using YouTube videos, students are using a modern, accessible, and adaptable tool for learning that consistently makes education available to all students, especially those who may benefit from digital learning platforms.

Republic Act No.10844, also known as " An act creating the Department of Information and Communications Technology, defining its powers and functions appropriating funds therefor, and for other purposes (Republic Act No. 10844 | GOVPH, 2016). Established the Department of Information and Communications Technology (DICT) in the Philippines. The law highlights the importance of ICT in nation-building, encourages digital literacy, and ensures that everyone has access to high-quality, low-cost ICT services. It seeks to improve the use of ICT in critical sectors, such as education, resulting in a more efficient, transparent, and competitive

society. The law encourages collaboration with educational institutions and authorities, such as DepEd and CHED, to improve ICT integration in education.

Republic Act No. 10612, also known as the "Fast-Tracked S&T Scholarship Act of 2013," is a law aimed at strengthening science and technology education in the Philippines, focusing on producing high-quality graduates in science, mathematics, and engineering (Republic Act No. 10612, n.d.). It also promotes the development of experienced teachers across various subjects and provides vital insights into teaching methods, including digital tools.

Republic Act No. 10612, also known as the "Fast-Tracked S&T Scholarship Act of 2013," is a law aimed at strengthening science and technology education in the Philippines, focusing on producing high-quality graduates in science, mathematics, and engineering (*Republic Act No. 10612*, n.d.). It also promotes the development of experienced teachers across various subjects and provides vital insights into teaching methods, including digital tools.

Republic Act No. 10650, also known as the "Open Distance Learning Act," allows students to be physically separated from their instructors and to employ a variety of learning methods and technologies, including online learning. Its purpose is to improve access to quality academic and technical vocational education through Open Distance Learning (ODL) (*Republic Act No. 10650*, n.d.). The Act authorized the University of the Philippines Open University (UPOU) to assist other schools in launching ODL programs. This project seeks to make education more accessible to a larger number of students. The government hopes that the Act will expand and strengthen the country's educational opportunities.

Republic Act 10533, also known as the "Enhanced Basic Education Act of 2013", is primarily concerned with upgrading and enhancing basic education, ensuring that it fits the needs of students at the fundamental level (Republic Act No. 10533 | GOVPH, 2013). However, it also recognizes the importance of integrating technology into the educational process, reflecting the growing popularity of digital learning. Online learning, as a critical component of current educational methods, is regarded as an effective way to reach a broader range of students, particularly those living in remote places or with restricted access to traditional learning environments. The integration of technology in education aims to create more flexible and accessible learning opportunities that fit with students' increasing demands in the digital era. The Act promotes the use of technology, paving the way for a more inclusive and innovative approach to education in the Philippines.

Kusmaryono and Basir (2024) concluded that the use of YouTube mathematics learning videos was beneficial for addressing gaps in students' knowledge and comprehension. These videos are a dynamic tool that not only attracts students' attention but also increases their emotional engagement, resulting in more positive learning. Furthermore, the videos were shown to significantly improve students' academic performance in mathematics, particularly their cognitive development. In addition, incorporating YouTube videos into the learning process demonstrates their usefulness, thereby increasing both students' interest and achievement in mathematics.

Paas & van Merriënboer, (2020) highlight the importance of considering how the learner, the learning task, and the learning environment are interconnected when creating an instructional strategy. Understanding the connections among these elements enables instructional designers to make informed decisions that effectively leverage learners' working memory resources. When learning mathematics, students' cognitive load may be affected using YouTube videos. Do the videos lower cognitive load by simplifying complex concepts, or do they increase it by providing too much information at once?

Çeken and Taşkın (2022) examined the growing trend in research on multimedia learning principles. They concluded that most studies were conducted in traditional learning environments, with a significant focus on learning outcomes. It opens the door to further exploration of how multimedia environments, including YouTube, can be better understood, and used in the context of educational technology.

Asanre et al. (2024) concluded that using YouTube videos as an instructional medium improved students' mathematics skill. The study highlights that teachers use YouTube as a teaching tool alongside other multimedia platforms, apply it in real-world circumstances, and adapt the videos to curricular objectives. This shows that YouTube could be a beneficial resource for improving math education.

Frederick-Jonah et al. (2020) found that using YouTube to enhance instructional techniques had a more significant positive effect on students' mathematical achievement than the standard modified lecture instructional strategy. Using YouTube enabled more engaging, interactive content, helping students better understand complex mathematical ideas. In addition, they concluded that the dynamic, visual nature of YouTube videos appealed to a variety of learning styles, thereby enhancing students' attention and recall of the material. Implementing a YouTube-enhanced educational technique has the potential to improve mathematics achievement among secondary school students significantly.

Maziriri et al. (2020) found that students reported positive perceptions of YouTube as a visual and practical representation of mathematical concepts, with videos that catered to various learning styles. Students learn more effectively with YouTube integration than with traditional learning.

Akorede et al. (2024) examined the effect of integrating YouTube as a teaching tool on students' academic achievement in mathematics and concluded that its use had a positive impact. It was suggested that teachers should include YouTube as a teaching tool in their lessons, alongside other multimedia platforms, apply it to real-world settings, and modify YouTube videos to align with curriculum objectives.

Patalinghug and Mark (2022) studied YouTube as an instructional tool for Technology-Enabled Learning (TEL). The study concluded that students who use YouTube more frequently and for more extended periods demonstrate greater acceptance. YouTube has the potential to improve students' sociability, motivation, academic achievement, and the delivery of the curriculum.

Nabayra (2022) found that teacher-created YouTube videos served as educational resources for online mathematics learning during the pandemic and that their use led to significant improvements in students' performance, highlighting their effectiveness in enhancing learning outcomes.

Insorio and Macandog (2022) evaluated the implementation of mathematics video tutorials through a YouTube channel for modular learning. The study concluded that YouTube video lessons are practical because they help students grasp mathematical concepts and enhance teaching.

Gyeltshen and Dorji (2023) investigated the effectiveness of integrating YouTube videos into mathematics instruction. The study concluded that YouTube videos can improve mathematics instruction and enhance student achievement, but that content selection is also crucial.

Karmila et al. (2021) noted that the use of interactive videos in mathematics learning activities, such as those available on YouTube, greatly improved students' mathematical communication skills, suggesting that such resources can effectively support mathematics instruction during difficult times.

Gil-Cordero et al. (2023) investigated the role of interactive YouTube videos in enhancing mathematics abilities during the pandemic. The study concluded that these videos considerably improved students' capacity to explain mathematical concepts clearly and effectively.

In light of the learning theories mentioned earlier, along with the reviewed literature and prior studies, this study will examine the effectiveness of YouTube videos in teaching Mathematics. The results of this study will serve as material for educators to enhance teaching strategies. Likewise, it would also be beneficial to other researchers, educational content creators, mathematics teachers, and school administrators by giving insights and creating an action plan to improve student performance and adapt teaching practices.

3. Objectives of the Study

This study aimed to assess the effectiveness of YouTube videos in teaching Mathematics among Grade 7 Junior High School (JHS) students at the University of Cebu at Pardo and Talisay, Bulacao Cebu City, Philippines. Viewed through the pretest and posttest results of both the control and experimental groups, the analysis examines whether there is a significant difference between their pre and posttest scores and whether a significant difference exists between the groups posttest scores. The results of this study will serve as the basis for the proposed action plan.

4. Methodology

4.1 Research Design

This study employs a quasi-experimental design with a pretest and posttest to assess the effectiveness of YouTube Videos in Teaching Mathematics among Grade 7 Junior High School students. The quasi-experimental design allows for the comparison of two groups: an experimental group that uses YouTube videos as the medium of instruction for the discussion, and a control group that uses standard instructional methods.

4.2 Research Subjects

The subjects for this study were Grade 7 junior high school students from the University of Cebu at Pardo and Talisay, Inc., during the Academic Year 2024-2025. To provide a fair and valid comparison between the experimental and control groups, the researcher matched respondents by gender and second-grade Math grade. The researcher established these criteria to minimize variation in prior academic performance and to maintain consistency between the two groups.

A total of 60 students participated in the study, with the researcher assigning 30 to the experimental group and 30 to the control group. The researcher paired each student in the experimental group with a student in the control group based on their second-quarter Math grade and gender. The researcher also constructed a matching table to illustrate the alignment between respondents in both groups (see Table 1).

Table 1

Matching of Research Subjects

Pair No.	Experimental Group	2 nd Quarter Letter Grade	Experimental Gender	Control Group	2 nd Quarter Letter Grade	Control Group Gender
1	Subject 1	98	Female	Subject 1	98	Female
2	Subject 2	98	Female	Subject 2	98	Female
3	Subject 3	96	Female	Subject 3	97	Female
4	Subject 4	92	Female	Subject 4	93	Female
5	Subject 5	92	Female	Subject 5	92	Female
6	Subject 6	90	Female	Subject 6	92	Female
7	Subject 7	89	Female	Subject 7	88	Female
8	Subject 8	88	Female	Subject 8	87	Female
9	Subject 9	87	Female	Subject 9	86	Female
10	Subject 10	83	Female	Subject 10	82	Female
11	Subject 11	80	Female	Subject 11	79	Female
12	Subject 12	80	Female	Subject 12	79	Female
13	Subject 13	78	Female	Subject 13	78	Female
14	Subject 14	77	Female	Subject 14	77	Female
15	Subject 15	75	Female	Subject 15	76	Female
16	Subject 16	97	Male	Subject 16	98	Male
17	Subject 17	94	Male	Subject 17	95	Male
18	Subject 18	90	Male	Subject 18	91	Male
19	Subject 19	86	Male	Subject 19	87	Male
20	Subject 20	85	Male	Subject 20	86	Male
21	Subject 21	84	Male	Subject 21	84	Male
22	Subject 22	82	Male	Subject 22	81	Male
23	Subject 23	81	Male	Subject 23	81	Male
24	Subject 24	78	Male	Subject 24	78	Male
25	Subject 25	78	Male	Subject 25	78	Male
26	Subject 26	78	Male	Subject 26	78	Male
27	Subject 27	77	Male	Subject 27	77	Male
28	Subject 28	77	Male	Subject 28	76	Male
29	Subject 29	76	Male	Subject 29	76	Male
30	Subject 30	75	Male	Subject 30	75	Male

4.2 Research Procedures

Gathering Data. The researcher gave a transmittal letter to the principal of the Junior High School Department. The letter requested permission to conduct the study among Grade 7 students and to obtain guardians' consent before data collection. The researcher also informed participants of their right to withdraw at any time. Throughout the study, all students' information remained private and anonymous.

After obtaining consent from the research subjects, the researcher administered a pretest to both the control and experimental groups to assess their baseline knowledge and skills in Mathematics. The researcher then used YouTube videos as the medium of instruction for discussing 3rd- to 4th-quarter lessons in the experimental group, while the control group received traditional classroom instruction. For thirty (30) days, the researcher integrated YouTube Videos to teach three (3) content domains in Math,

specifically Numbers, Algebra, and Data Probability. Each week focused on different topics depending on the learning competencies, with YouTube videos playing a significant role in delivering lessons, reinforcing concepts, and providing step-by-step demonstrations for problem-solving in the experimental group.

In the first week, the researcher focused on Number topics, such as the GEMDAS (Grouping, Exponent, Multiplication, Division, Addition, and Subtraction) Rule and Absolute Value. The researcher used YouTube videos to explain essential concepts, with visual, step-by-step demonstrations of these mathematical operations. Students watched the selected YouTube videos before engaging in guided practice.

From the second to sixth weeks, the researcher covered Algebra topics, including Solving Simple Equations using the Bar Model, Evaluating Algebraic Expressions, Writing Algebraic Expressions, Properties of Equality, and Writing and Solving Equations. YouTube videos were used to explain these concepts, providing step-by-step demonstrations and visual representations to enhance students' learning.

In the final week, the researcher covered Data and Probability, focusing on topics of Experiments, Tables, and Graphs. YouTube videos were used to guide students through organizing data, conducting simple experiments, and presenting results in tables and graphs.

YouTube videos were carefully selected to be age-appropriate, aligned with the curriculum, and supportive of students' understanding. They were used to explain concepts visually, demonstrate problem-solving step by step, and reinforce classroom instruction. After completing all weeks of interventions, the researcher administered a posttest to determine the students' performance and evaluate the effectiveness of using YouTube video lessons as the medium of instruction for the discussion. After gathering data, the researcher tallied, analyzed, and interpreted the study's results while maintaining the anonymity and confidentiality of the participants. Precautionary measures were taken to ensure that students experienced no academic, psychological, or emotional harm and to ensure equal access to learning resources for both experimental and control groups.

5. Results and Discussion

This section deals with the presentation, analysis, and interpretation of data gathered from the pre-test and post-test scores and the significant difference between the two groups of respondents.

Table 2
Pretest Performances of the Research Subjects

A. Control Group Pretest	Score Ranges	Frequency	Percent
Did Not Meet Expectations	0 to 17	29	97%
Satisfactory	21 to 23	1	3%
B. Experimental Group Pretest	Score Ranges	Frequency	Percent
Did Not Meet Expectations	0 to 17	30	100%
Total		30	100%

Legend: Outstanding (27 to 30); Very Satisfactory (24-26); Satisfactory (21-23); Fairly Satisfactory (18-20); Did Not Meet Expectation (0-14).

Table 2 shows that the pretest results indicate that both the experimental (97%) and control (100%) groups performed at a low level of performance before the intervention. This indicates that both groups started with comparable low performance levels, as almost all participants had scores below the predicted range on the pretest. The observed pretest results indicate that both the experimental and control groups were statistically equivalent in their initial low proficiency in the subject matter or skills being assessed. This baseline similarity is important because it reduces the risk of bias and strengthens the study's internal validity.

This means that neither group had an initial advantage. This is crucial for the study because it ensures that any improvement seen in the experimental group (who use YouTube videos) can be more confidently attributed to the intervention itself rather than to prior knowledge differences. This fulfills an important condition for testing effectiveness, that any significant difference in posttest scores between the groups will reflect the effectiveness of using YouTube videos as a teaching tool. This strengthens the idea of whether YouTube videos are an effective instructional method in mathematics.

Majka (2024) states that pretesting is conducted before an intervention to establish the research subjects' baseline, providing a basis for comparison. Post-testing is conducted after the intervention to assess outcomes and determine its effectiveness by comparing posttest results with the baseline.

Table 3
Posttest Performances of the Research Subjects

A. Control Group Posttest	Score Ranges	Frequency	Percent
Outstanding	27 to 30	21	70%
Very Satisfactory	24 to 26	8	27%
Satisfactory	21 to 23	1	3%
B. Experimental Posttest	Score Ranges	Frequency	Percent
Outstanding	27 to 30	26	87%
Very Satisfactory	24 to 26	4	13%
Total		30	100%

Legend: Outstanding (27 to 30); Very Satisfactory (24-26); Satisfactory (21-23); Fairly Satisfactory (18-20); Did Not Meet Expectation (0-14).

Table 3 shows that the posttest shows a significant improvement in performance for both experimental and control groups following the intervention. The experimental group (87%) scored better than the control group (70%) in "Outstanding" performance (27-30), indicating that the intervention led to a higher percentage of high achievers. The control group scored (27%) in the "Very Satisfactory" performance (24-26), compared to only (13%) in the experimental group. This means that, rather than performing at a lower level, students in the experimental group increased their performance in the outstanding performance category. Despite both groups benefiting from instructions, the experimental group that received intervention via YouTube videos achieved higher performance levels, as indicated by these results, which show a significant increase.

This means, for critical thinking, that using YouTube videos as the medium of instruction can significantly enhance students' performance in Mathematics compared to traditional teaching methods. Although both the experimental and control groups showed improvement from the pretest to the posttest, the experimental group showed significantly greater improvement. These findings conclude that the use of multimedia, such as YouTube video lessons, may enhance interest and improve learners' memorization and knowledge retention in mathematics. The studies suggest using visual and online learning devices as a possible reinforcement of, or even a substitute for, in-class teaching in math education.

Traditional classrooms offer an organized environment that encourages students to stay focused and on task. Furthermore, traditional classrooms often provide students with access to a variety of tools, including textbooks and other materials that help them learn more effectively (Potomac, 2023). Traditional classrooms provide a structured learning environment where students can stay focused and engaged in their studies. The presence of a teacher, regular sessions, and a dedicated physical location all help to maintain discipline and reduce distractions. Furthermore, typical classrooms provide students with a variety of educational tools and resources, including textbooks, printed handouts, and other instructional materials. These resources not only support different learning styles but also enhance the overall learning experience by making abstract concepts more concrete and understandable.

However, information delivered through both verbal and visual channels, as in multimedia formats, learners understand and remember it better. YouTube videos that combine animation, narrative, and images improve learning outcomes by enhancing cognitive processing (Mayer, 2020). Multimedia instruction, like YouTube videos, can be a more effective teaching method than traditional lectures in mathematics education. Moreover, using YouTube not only aligns with how students learn and build knowledge but also enhances cognitive load management during learning (Paas and van Merriënboer, 2020). This two-way support explains why the experimental group that was taught using multimedia instruction showed significantly greater improvement on the posttest than the control group that was taught using traditional lectures.

In addition, YouTube videos can improve mathematics instruction and student performance; however, their successful integration relies on the careful selection of acceptable and relevant video content (Dorji, 2023). YouTube videos can significantly improve mathematics education by delivering dynamic, visual explanations that make complex ideas more accessible and engaging for students. When used properly, these videos can support a variety of learning styles, reinforce classroom instruction, and improve

student engagement and comprehension. The influence of videos on student learning outcomes still relies on teachers because it requires careful selection of high-quality, age-appropriate, and curriculum-aligned video content, and teachers must ensure that the videos are both instructional and relevant to the specific topics being taught.

Table 4
Significant Difference between the Pretest Performances of the Control and Experimental Groups

Subjects' Pretest Scores	n	Mean	Sd	Ind. t-test Value	p-Value	Decision Ho	Remarks
A. Control Group	30	10.50	4.09	0.389	0.263	Failed to Reject	Not Significant
B. Experimental Group	30	10.87	3.15				

**Significant @ =0.05 level*

Table 4 presents the pretest scores of the control and experimental groups using an independent t-test. The result shows no significant difference in pretest scores between the control and experimental groups ($p = 0.263 > 0.05$). The computed t-test statistic is 0.389, with a p-value of 0.263, which is larger than the chosen level of significance of 0.05, leading to rejection of the null hypothesis. This indicates that both groups had comparable performance levels before the intervention.

The results show that there is no significant difference in the two groups' pretest scores, indicating that both groups started at the same level of mathematical knowledge before any intervention. The differences in the students' posttest scores can therefore be explained by the intervention itself and by any pre-existing differences in knowledge. This initial similarity adds to the study's validity and emphasizes the neutrality of the comparison between the effectiveness of the two pedagogical methods: traditional lectures for the control group and YouTube videos for the experimental group. The results ensure that the study adequately measures the effect of YouTube videos on student learning outcomes, free of bias introduced by unequal starting points between groups.

Campbell and Stanley (2020) argue that when groups are equivalent at the start, the results of any differences observed in the post-intervention assessment can be confidently attributed to the intervention itself. It explains the importance of establishing baseline similarity between control and experimental groups before an intervention. In addition, Elkins (2019) believes that when groups share similar characteristics at the start, and only one group receives intervention, any differences in outcomes can be attributed to that intervention. This supports that study groups should be matched before an intervention is applied. When two groups have equal baseline measures before an intervention, outcome differences following the intervention can be attributed to the intervention with a high degree of certainty.

Table 5
Significant Difference between the Pretest and Posttest Performance of the Control Group

Control Group	n	Mean	Sd	P. t-test Value	df	p-Value	Decision	Remark
Pretest Scores	30	10.50	4.09	23.35	29	< 0.001	Reject Ho	Significant
Posttest Scores	30	27.77	1.81					

**Significant @ =0.05 level*

Table 5 presents the Difference between the pretest and posttest performance of the control group. The paired t-test for the control group shows a significant improvement from pretest to posttest ($p < 0.001$). This indicates that the control group made substantial gains after the intervention. The null hypothesis was therefore rejected, showing that the traditional teaching method had a statistically significant effect on students' performance.

This finding indicates important implications for the study. It establishes that traditional instruction is effective in promoting learning improvement in mathematics. However, if the experimental group that used YouTube videos for instruction demonstrates even greater improvements, it would show that multimedia learning may provide benefits in addition to traditional teaching. This provides a practical foundation for comparing the two teaching techniques and demonstrates the potential of technology-enhanced education to improve academic outcomes.

Traditional lecture-style pedagogy in mathematics education has remained extremely effective across many generations of students (Tularam, 2019). The pedagogy, with its formal presentation of content, clear examples, and systematic working through of mathematical ideas, has produced a high percentage of successful students over many decades. Despite changing pedagogical

models, the value of traditional teaching remains widely accepted and largely unproblematic, underscoring its continued relevance in the development of mathematical critical skills.

De Jong et al. (2023) highlighted that, especially for beginner students, clear and direct instructions frequently yield better learning outcomes than unguided inquiry approaches. Traditional teacher-led instruction helps students in learning more by providing scaffolding, modeling, and structured supervision. In subjects like mathematics, where students require teachers to clearly and systematically explain abstract concepts, this further highlights the importance of the traditional teaching approach.

Table 6
Significant Difference between the Pretest and Posttest Performance of the Experimental Group

Experimental Group	n	Mean	Sd	P. t-test Value	df	p-Value	Decision	Remark
Pretest Scores	30	10.870	3.15	29.98	29	< 0.001	Reject Ho	Significant
Posttest Scores	30	28.67	1.65					

**Significant @ =0.05 level*

Table 6 presents the Difference between the pretest and posttest performance of the experimental group. The experimental group showed a significant improvement from pretest to posttest ($p < 0.001$), indicating that the intervention had a strong positive effect on their performance. The null hypothesis is rejected, indicating that the Difference in scores is not due to chance but to the teaching method.

The significant increase seen indicates that the use of YouTube videos as a teaching aid is most effective in enhancing students' understanding and performance in Mathematics. The significant shift from pretest to posttest indicates that these YouTube videos have the potential to communicate knowledge in a way that is not only engaging but also clear and easily understandable, promoting cognitive processing and memory retention among students. This result, compared with the control group's improvements, demonstrates the potential of multimedia learning materials to improve educational outcomes. It supports the idea that using digital platforms like YouTube in teaching strategies can supplement or even improve traditional instruction, making it a vital resource for modern education, especially in areas that require step-by-step conceptual comprehension, such as mathematics.

The flipped classroom strategy significantly improved students' mathematics achievement compared to traditional classroom environments (Wei et al., 2020). The research showed that this method significantly improved students' mathematical achievement compared to traditional teaching. Through video lectures, note-taking homework, and in-class teamwork on problems, this strategy increased student engagement and comprehension, resulting in greater retention of knowledge. In addition, Gyeltshen and Dorji (2023) study showed that YouTube videos can be a valuable resource for supporting mathematics teaching and student performance by providing an interactive and engaging medium for delivering mathematical concepts. However, the study emphasized the importance of content choice in achieving the best possible effectiveness for YouTube videos. Careful selection of videos to ensure compatibility with the curriculum, accuracy, and the provision of concise, relevant examples is important. Use of poor or low-quality content may lead to confusion, thus negating the desired effects of video learning.

Table 7
Significant Difference between the Posttest Performance of the Control and Experimental Group

Subjects' Posttest Scores	n	Mean	Sd	t-test Value	p-Value	Decision Ho	Remarks
A. Control Group	30	27.67	1.81	2.012	0.049	Reject Ho	Significant
B. Experimental Group	30	28.67	1.65				

**Significant @ =0.05 level*

Table 7 presents a comparison of posttest scores for the control and experimental groups. The independent t-test on posttest scores shows a significant difference between the control and experimental groups ($p = 0.049 < 0.05$). This suggests that the experimental group outperformed the control group after the intervention. Therefore, the null hypothesis is rejected, indicating a statistically significant difference in posttest performance between the experimental and control groups.

This finding means that students who learned from YouTube videos outperformed those who received traditional instruction. The statistically significant Difference in posttest scores indicates that using video-based instruction positively improved students' mathematical learning outcomes.

Cognitive Load Theory (CLT) suggests that learning is most effective when cognitive load is optimized, and YouTube videos can aid in this by presenting mathematical concepts in both visual and verbal formats, reducing cognitive overload (Sweller, 2023). The study's findings, which show a significant difference between the posttest results of the control group (traditional teaching) and the experimental group (YouTube videos), support this idea. YouTube videos help students manage cognitive load by breaking down complex problems into easy-to-follow, step-by-step visual explanations. This approach makes it easier for them to grasp the material and reduces the mental effort needed to understand challenging concepts. By using both visual and verbal cues, the videos promote better comprehension and performance in mathematics, showing that this approach can be more effective than traditional teaching methods in lowering cognitive load and boosting learning.

This contributes to the study's primary goal of examining the effectiveness of YouTube videos as a teaching tool. It implies that multimedia resources can improve understanding, engagement, and academic achievement, possibly by reducing cognitive overload and presenting information in a more visually accessible way. Educators and curriculum writers may consider incorporating such digital tools to supplement traditional instruction, particularly in areas that benefit from visual explanations and repetition, such as mathematics.

6. Conclusion

The results of the study provide strong evidence that integrating YouTube videos into mathematics instruction significantly improves students' academic performance. Although both the control and experimental groups showed gains from pretest to posttest, the experimental group demonstrated significantly higher posttest scores. This confirms that video-based instruction is more effective than traditional teaching methods alone in enhancing students' learning outcomes. Overall, the integration of YouTube videos in teaching mathematics leads to greater academic achievement and improved understanding of mathematical concepts.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

ORCID ID

0000-0001-5622-2778

0000-0003-4486-5826

0000-0002-7851-631X

0000-0002-0287-9624

0000-0002-2333-7269

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

References

- [1] Akorede, A., Sondlo, A., Ogunyale, A., Olusola, G., & Sottin, D. (2024). Effect of integrating YouTube as a teaching tool on the academic achievement of senior secondary school students in mathematics. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education*, 5(2), Article 2, 82–86.
- [2] Asanre, A. A., Aviwe, S., Ogunyale, A., Olusola, G., & Sottin, D. (2024). Effect of integrating YouTube as teaching tool on the academic achievement of senior secondary school students in mathematics. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education*, 5(2), Article 2.
- [3] Campbell, D. T., & Stanley, J. C. (2015). *Experimental and quasi-experimental designs for research*. Ravenio Books.
- [4] Çeken, B., & Taşkın, N. (2022). Multimedia learning principles in different learning environments: A systematic review. *Smart Learning Environments*, 9(1), 19. <https://doi.org/10.1186/s40561-022-00200-2>
- [5] de Jong, T., Lazonder, A. W., Chinn, C. A., Fischer, F., Gobert, J., Hmelo-Silver, C. E., Koedinger, K. R., Krajcik, J. S., Kyza, E. A., Linn, M. C., Pedaste, M., Scheiter, K., & Zacharia, Z. C. (2023). Let's talk evidence: The case for combining inquiry-based and direct instruction. *Educational Research Review*, 39, 100536. <https://doi.org/10.1016/j.edurev.2023.100536>
- [6] Dorji, C. (2023). Effectiveness of using YouTube videos in mathematics classes of Class VI students. *International Journal of All Research Education and Scientific Methods*, 11(10), 1679–1692.
- [7] Elkins, M. R. (2015). Assessing baseline comparability in randomised trials. *Journal of Physiotherapy*, 61(4), 228–230. <https://doi.org/10.1016/j.jphys.2015.07.005>

- [8] Frederick-Jonah, T. M., Akporehwe, N. J., & Jonah, E. (2020). Effect of YouTube-enhanced instructional strategy on secondary school students' achievement in mathematics.
- [9] Gil-Cordero, E., Rodríguez-Rad, C., Ledesma-Chaves, P., & Sánchez del Río-Vázquez, M.-E. (2023). Analysis of factors affecting the effectiveness of face-to-face marketing learning via TikTok, YouTube, and video conferencing. *Heliyon*, 9(7), e17195. <https://doi.org/10.1016/j.heliyon.2023.e17195>
- [10] Gottfried, M. A., Faverio, M., & Smith, A. (2023, December 11). *Teens, social media and technology 2023*. Pew Research Center. <https://www.pewresearch.org/internet/2023/12/11/teens-social-media-and-technology-2023/>
- [11] Gyeltshen, G., & Dorji, C. (2023). Effectiveness of using YouTube videos in mathematics classes of Class VI students. *International Journal of All Research Education and Scientific Methods*, 11, 1679–1692.
- [12] Insorio, A. O., & Macandog, D. M. (2022). Video lessons via YouTube channel as mathematics interventions in modular distance learning. *Contemporary Mathematics and Science Education*, 3(1), e22001. <https://doi.org/10.30935/conmaths/11468>
- [13] Karmila, D., Putri, D., Berlian, M., & Fatrima. (2021). The role of interactive videos in mathematics learning activities during the COVID-19 pandemic <https://doi.org/10.2991/assehr.k.210227.024>
- [14] Kusmaryono, I., & Basir, M. A. (2024). Learning media projects with YouTube videos: A dynamic tool for improving mathematics achievement. *International Journal of Evaluation and Research in Education*, 13(2), 934. <https://doi.org/10.11591/ijere.v13i2.26720>
- [15] Majka, M. (n.d.). *Understanding the importance of pre- and post-testing in research and evaluation*.
- [16] Mayer, R. E. (2001). *Multimedia learning*. Cambridge University Press.
- [17] Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press. <https://doi.org/10.1017/9781316941355>
- [18] Maziriri, E. T., Gapa, P., & Chuchu, T. (2020). Student perceptions towards the use of YouTube as an educational tool for learning and tutorials. *International Journal of Instruction*, 13(2), 119–138.
- [19] Nabayra, J. (2022). Mathematics learning in the new normal through teacher-created videos: The freshmen university students' experience. *International Journal of Arts and Humanities Studies*, 2(1), Article 1. <https://doi.org/10.32996/bjahs.2022.2.1.4>
- [20] Paas, F., & van Merriënboer, J. J. G. (2020). Cognitive load theory: Methods to manage working memory load in the learning of complex tasks. *Current Directions in Psychological Science*, 29(4), 394–398. <https://doi.org/10.1177/0963721420922183>
- [21] Patalinghug, H. F., & Mark, P. (2022). YouTube as a web-based instructional tool in higher education during the COVID-19 pandemic (SSRN Scholarly Paper No. 4439811). Social Science Research Network. <https://papers.ssrn.com/abstract=4439811>
- [22] Piaget, J. (1964). Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, 2(3), 176–186. <https://doi.org/10.1002/tea.3660020306>
- [23] Republic Act No. 10533. (2013). *Enhanced Basic Education Act of 2013*. Official Gazette of the Republic of the Philippines. <https://www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/>
- [24] Republic Act No. 10612. (2013). https://lawphil.net/statutes/repacts/ra2013/ra_10612_2013.html
- [25] Republic Act No. 10650. (2014). https://lawphil.net/statutes/repacts/ra2014/ra_10650_2014.html
- [26] Republic Act No. 10844. (2016). *Department of Information and Communications Technology Act*. Official Gazette of the Republic of the Philippines. <https://www.officialgazette.gov.ph/2016/05/23/republic-act-no-10844/>
- [27] Sweller, J. (2023). Cognitive load theory: What we learn and how we learn. In J. M. Spector, B. B. Lockee, & M. D. Childress (Eds.), *Learning, design, and technology* (pp. 137–152). Springer. https://doi.org/10.1007/978-3-319-17461-7_50
- [28] Tularam, G. A. (2018). Traditional vs. non-traditional teaching and learning strategies: The case of e-learning. *International Journal for Mathematics Teaching and Learning*, 19(1), Article 1. <https://doi.org/10.4256/ijmtl.v19i1.21>
- [29] Wei, X., Cheng, I.-L., Chen, N.-S., Yang, X., Liu, Y., Dong, Y., Zhai, X., & Kinshuk. (2020). Effect of the flipped classroom on the mathematics performance of middle school students. *Educational Technology Research and Development*, 68(3), 1461–1484. <https://doi.org/10.1007/s11423-020-09752-x>