Vol. 3 Núm. 1 (2026)- pp. 13-27
Multidisciplinary Journal
Ciencia Kawsay

Social Networks (YouTube) as a Dynamizing Agent in the Learning of Mathematics and Experimental Sciences

Redes Sociales (YouTube) como agente dinamizador del aprendizaje de las matemáticas y las ciencias experimentales

Almachi Iza Diego Javier
0009-0009-2748-9284
Universidad Internacional de la Rioja (UNIR)
diegojai_1996@live.com
Gualpa Almachi Jenny Paulina
0009-0009-3639-9803
Universidad Central del Ecuador, Ecuador
jenny-pauly26@hotmail.com

Received: 23/11/2025
Accepted: 03/02/2026
Published: 12/02/2026

Citation: Almachi Iza, D. J. y Gualpa Almachi, J. P. (2026). Social Networks (YouTube) as a Dynamizing Agent in the Learning of Mathematics and Experimental Sciences. *Ciencia Kawsay, 3*(1), 13 – 27.

Abstract: The educational use of YouTube intensified during the COVID-19 pandemic, particularly in mathematics, given the challenges posed by its abstract language. This study aimed to analyze the influence of YouTube videos on mathematics teaching and learning processes based on literature published between 2015 and 2022. A systematic review was conducted using EBSCO, Google Scholar, SciELO, and ERIC, following the PRISMA 2020 flowchart; out of 98 initial records, 20 studies were selected for qualitative synthesis. The results show that 50% of the studies address the video as a learning tool, 40% focus on the teacher's role in creating and selecting videos, and 10% examine the historical context and the pandemic. The discussion highlights that videos enable students to learn at their own pace, review content, and increase their interest in mathematics; however, their effectiveness depends on teacher mediation, material quality, and access to devices and the internet. The study concludes that while YouTube is a valuable complement to mathematics instruction, it does not replace the teacher and necessitates the strengthening of digital competence and the reduction of the access gap.

Keywords: educational video; open educational resources; self-directed learning; teacher digital competence; academic performance.

Resumen: *El uso educativo de YouTube se intensificó durante la pandemia de COVID-19, especialmente en matemática debido a la dificultad de su lenguaje abstracto. El objetivo del estudio fue analizar la influencia de los videos de YouTube en los procesos de enseñanza y aprendizaje de la matemática a partir de la literatura publicada entre 2015 y 2022. Se realizó una revisión sistemática en EBSCO, Google Académico, SciELO y ERIC, siguiendo el diagrama PRISMA 2020; de 98 registros iniciales se seleccionaron 20 estudios para la síntesis cualitativa. Los resultados muestran que el 50% aborda el video como herramienta de aprendizaje, el 40% el papel docente en su creación y selección, y el 10% el contexto histórico y la pandemia. La discusión evidencia que los videos permiten aprender al propio ritmo, repasar contenidos y aumentar el interés por la matemática, aunque su efectividad depende de la mediación docente, la calidad del material y el acceso a dispositivos e internet. Se concluye que YouTube es un complemento valioso para la enseñanza de la matemática, pero no sustituye al docente y requiere fortalecer la competencia digital y reducir la brecha de acceso.*

Palabras clave: *video educativo; recursos educativos abiertos; aprendizaje autónomo; competencia digital docente; rendimiento académico.*

INTRODUCTION

Video has become one of the most widely used resources in teaching, especially since platforms such as YouTube, created in 2005, provided free access to a large amount of educational content (Vital-Rumebe *et al*., 2021) . The evidence on its effectiveness is favorable. conducted a systematic review and meta-analysis of 105 randomized trials involving 7,776 higher education students. They found that replacing existing teaching methods with video led to small improvements in learning (g = 0.28), whereas supplementing existing teaching with video produced substantial benefits (g = 0.80).

In mathematics, this resource is especially relevant. The formal and abstract language of the subject hinders comprehension for a portion of students, and video allows students to pause, replay, and review procedures at their own pace. In Mexico, (Esparza Puga & Aguilar, 2023) conducted focus groups with 22 university engineering students about their experience with the videos of the julioprofe channel. They concluded that the mathematical help obtained on YouTube is multifunctional, always available, private, easy to use, and adapted to each person's pace, qualities that students do not find in traditional school settings.

The COVID-19 pandemic intensified this trend. The closure of educational institutions forced teaching to move to virtual environments without enough time to train teachers and students in the pedagogical use of digital tools . In this context, teachers turned more frequently to videos hosted on YouTube as a means of instruction across different disciplines and educational levels (Navarro & Céspedes, 2021a) . Audiovisual resources thus came to play a leading role in virtual education (Alberto Chávez Ramos *et al*., 2021a).

However, a video's popularity does not guarantee its didactic quality. (Teruel Rodríguez *et al*., 2024) evaluated the 150 most-viewed English-language explanation videos on YouTube on three school mathematics topics: multiplication of fractions, the Pythagorean theorem, and the intersection of linear functions. The study found that most videos are mathematically correct and use appropriate language, but few explain the meaning of concepts, link different representations, or connect mathematics to real-world contexts. For each topic, more than half of the videos merely described the steps of a procedure. Moreover, selecting appropriate resources requires specific training: in a study with 24 pre-service primary school teachers, their assessments of mathematics videos on percentages were generally imprecise, although they recognized that teachers need to analyze the relevance of these resources before recommending them to students (Navarro & Céspedes, 2021a).

The use of these resources also depends on access to technology. In Ecuador, according to the National Survey of Employment, Unemployment and Underemployment of July 2025, 71.3% of households had internet access. The figure was 76.6% in urban areas and 58.7% in rural areas. In households whose head belonged to the lowest income quintile, it reached 50.8%, compared with 84.3% in the highest. The gap is wider in equipment: only 16.2% of rural households had a desktop computer, laptop, or tablet, compared with 39.6% of urban households (Del Valle-ramón *et al*., 2020).

Research on educational video is abundant, but a large share of the synthesized experimental evidence comes from other contexts. The review by (2024) , for example, is limited to university students and covers a variety of disciplines. In contrast, studies on the use of YouTube in mathematics teaching in Spanish-speaking contexts are scattered across different educational levels, countries, and methodological approaches. A systematic synthesis of this literature makes it possible to identify what YouTube contributes to mathematics learning, under what conditions it does so, and what obstacles limit its implementation. This information is useful for teachers, institutions, and education policymakers in Ecuador.

Accordingly, the aim of this study was to analyze the influence of YouTube videos on the teaching and learning of mathematics through a systematic review of the literature published between 2015 and 2022. Three research questions arise from this aim: (a) what is the relationship between the use of YouTube and its applicability in the educational setting?; (b) what is YouTube's contribution to mathematics education?; and (c) is YouTube a valid and reliable medium for developing learning processes?.

MATERIALS AND METHODS

Study design

This study is a systematic literature review with a qualitative synthesis of its findings. It derives from the author's undergraduate thesis at the Universidad Técnica Particular de Loja (Ecuador), completed in 2022. The study selection process is reported in accordance with the PRISMA 2020 statement (Page *et al*., 2021). The review protocol was not registered in advance.

Eligibility criteria

Studies were included if they (a) were published between 2015 and 2022, (b) addressed the use of YouTube or educational videos in educational settings, with emphasis on the teaching and learning of mathematics, and (c) provided information relevant to the research questions. Studies were excluded if they were duplicates, fell outside the study period, were unrelated to the topic of the review, or did not provide relevant information after full-text reading. The number of records excluded under each criterion is presented below (see Table 1).

Table 1. Exclusion criteria and number of records excluded at each stage

Stage	Exclusion criterion	Records excluded
Identification	Duplicate records	13
Screening	Published outside the 2015–2022 period	46
Screening	Not related to the topic of the review	13
Full-text reading	No information relevant to the research questions	6
Total		**78**

Information sources and search strategy

The search was conducted in 2022 in four sources: EBSCO, Google Scholar, SciELO, and ERIC. It used the following combinations of keywords and Boolean operators: YouTube + Matemáticas; YouTube AND Matemáticas; Videos + Matemáticas; YouTube AND Educación; Educación AND Matemáticas AND Online; and Educación OR rendimiento académico OR Matemáticas. The search retrieved 98 records in total.

The exact date of each search, the filters applied in each source, and the number of records retrieved from each source were not recorded. In addition, Google Scholar does not allow fully reproducible searches. These aspects limit the reproducibility of the search and are addressed in the Discussion.

Selection process

The author first removed duplicate records (n = 13) and then screened the remaining 85 records in two steps. In the first step, records published outside the 2015–2022 period were excluded (n = 46). In the second step, the remaining 39 records were screened for relevance, and those unrelated to the topic of the review were excluded (n = 13). The full texts of the remaining 26 studies were then read, and six of them were excluded because they did not provide information relevant to the research questions. Finally, 20 studies were included in the review. A single reviewer carried out the entire selection process. The flow of records through each stage is shown in the PRISMA diagram (see Figure 1).

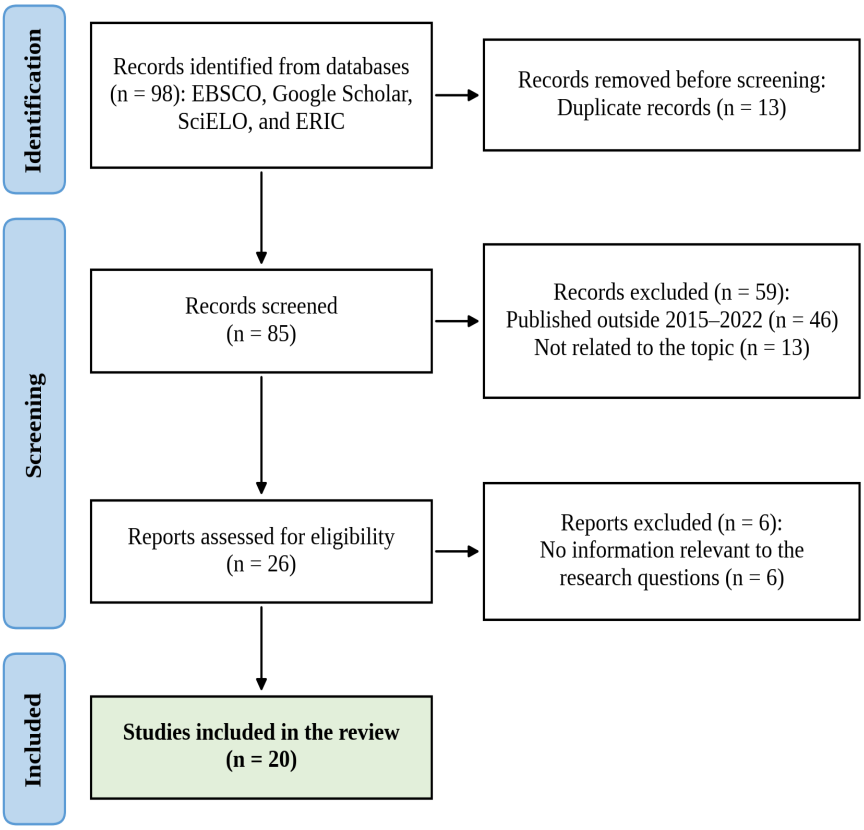


Figure 1. PRISMA 2020 flow diagram of the study selection process

Note: Adapted from Page et al. (2021).

Data extraction

The data from each included study were recorded in a registration and classification chart designed for this review. The chart included the following fields: source, title, authors, year, thematic category, and main contribution to the research questions.

Synthesis of results

Given the heterogeneity of designs, educational levels, and outcomes among the included studies, a meta-analysis was not feasible. Instead, a qualitative thematic synthesis was conducted. Each study was classified according to its main theme into one of nine thematic categories, and these categories were then grouped into three analytical axes: (a) the video as a learning tool, (b) the teacher's role in selecting and creating videos, and (c) the historical context and the pandemic. The number and percentage of studies in each category and axis are reported descriptively. The methodological quality of the included studies was not formally assessed.

Ethical considerations

This review used only publicly available documents and did not involve human participants. Therefore, approval from an ethics committee and informed consent were not required.

RESULTS AND DISCUSSION

Characteristics of the included studies

The review included 20 studies published between 2016 and 2022; no study from 2015 met the eligibility criteria. The year with the most studies was 2021 (n = 5), followed by 2017 and 2018 (n = 4 each) (see Table 2). All included studies were published in Spanish. The studies covered different educational levels, from primary education to higher education and teacher training.

Table 2. Distribution of the included studies by year of publication

Year	n	%
2016	2	10
2017	4	20
2018	4	20
2019	1	5
2020	3	15
2021	5	25
2022	1	5
Total	**20**	**100**

Thematic categories

The thematic synthesis identified nine categories, grouped into three axes (see Table 3). The first axis, the video as a learning tool, accounted for half of the studies (n = 10; 50%). The second axis, the teacher's role in selecting and creating videos, included eight studies (40%). The third axis, the historical context and the pandemic, included two studies (10%). The main finding of each study is presented below (see Table 4).

Table 3. Included studies by axis and thematic category

Axis	Thematic category	n	%
Axis 1. The video as a learning tool	Learning tool	6	30
	Classroom implementation	4	20
	Subtotal	10	50
Axis 2. The teacher's role in selecting and creating videos	Video suitability criteria	1	5
	Evaluation of a channel catalogue	1	5
	YouTube as a teaching tool	2	10
	Teacher training	2	10
	Creation of educational videos	2	10
	Subtotal	8	40
Axis 3. The historical context and the pandemic	Origin and history of video	1	5
	Teaching during the pandemic	1	5
	Subtotal	2	10
Total		**20**	**100**

Table 4. Main finding of each included study

No.	Study	Category	Main finding
1	(Pedrosa *et al.*, 2020)	Learning tool	Secondary students valued class recordings as a valid learning aid but stressed the irreplaceable role of the teacher.
2	(Beltrán-Pellicer & Giacomone, 2021)	Learning tool	Many online videos address measures of central tendency, but few explain when the median is preferable to the mean.

No.	Study	Category	Main finding
3	(Padilla *et al.*, 2020)	Learning tool	Ecuadorian young people use YouTube tutorials to learn autonomously and solve situations in their school life.
4	(Shoufan & Mohamed, 2022)	Learning tool	Students in Bogotá use video tutorials as a non-formal education resource because the audiovisual format makes learning easier.
5	(Reyes, 2022)	Learning tool	Video complements textbooks and lecture notes in university mathematics teaching.
6	(Masero-Moreno, 2022)	Learning tool	A digital tutorial supported university students' out-of-class work in a flipped classroom model.
7	(Breslyn & Green, 2022)	Classroom implementation	Educational videos benefited the learning of subtraction and multiplication algorithms in second grade and increased interest in mathematics.
8	(Ríos Vázquez & Romero Tena, 2022)	Classroom implementation	Video as an open educational resource in a blended modality improved the understanding of conceptual and procedural geometry content.
9	(Pattier, 2022)	Classroom implementation	Mathematics videos on the institutional platform reinforced learning in a university course with high failure rates.
10	(Malvasi & Hueso Romero, 2023)	Classroom implementation	An online tutorial system improved in-service teachers' knowledge of early mathematics instruction.
11	(Navarro & Céspedes, 2021b)	Video suitability criteria	The assessments of mathematics videos by 61 pre-service teachers were imprecise; training is needed to analyze them critically.

No.	Study	Category	Main finding
12	(Ayala Chauvin, 2023)	Evaluation of a channel catalogue	YouTube contains high-quality mathematics teaching resources with diverse characteristics.
13	(Bitzenbauer *et al*., 2024)	YouTube as a teaching tool	The Unicoos channel combines traditional resources, such as the whiteboard, with animations, infographics, and augmented reality.
14	(del Valle-Ramón *et al*., 2020)	YouTube as a teaching tool	Project-based learning with YouTube had a positive influence on the acquisition of mathematical knowledge in primary education.
15	(Espinel-Rubio & Feo-Ardila, 2022)	Teacher training	Pre-service mathematics teachers built knowledge about teaching through interactions around videos in virtual environments.
16	(Shao *et al*., 2024)	Teacher training	The convergence of social networks and video opens opportunities for teacher training.
17	(Bitzenbauer *et al*., 2024)	Creation of educational videos	Learning progressions in the creation of audiovisuals help to design activities that build on prior knowledge.
18	(Burgos *et al*., 2020)	Creation of educational videos	Working with video broadens the teaching possibilities of the classroom and enables learning by doing.
19	(Vital-Rumebe *et al*., 2021b)	Origin and history of video	Audiovisual materials became more accessible, and educational programs adapted to them.
20	(Alberto Chávez Ramos *et al*., 2021b)	Teaching during the pandemic	Audiovisual resources played an exceptional role in virtual education during the pandemic.

Axis 1. The video as a learning tool

Ten studies examined the use of videos to support the learning of mathematics. Four of them analyzed their implementation in the classroom. In primary education,

educational videos benefited the learning of subtraction and multiplication algorithms and increased students' interest in mathematics (Pedrosa *et al*., 2020) . In secondary education, video used as an open educational resource in a blended modality improved the understanding of geometry content (Rodríguez-Bravo *et al*., 2021) . In higher education, videos hosted on the institutional platform reinforced learning in a course with high failure rates (Ayala Chauvin, 2023) . In addition, an online tutorial system improved in-service teachers' knowledge of early mathematics instruction (Shao *et al*., 2024).

The other six studies analyzed video as a learning tool inside and outside the classroom. Students valued it as a valid aid, although they stressed that the teacher plays an irreplaceable role (Pedrosa *et al*., 2020) . Outside the classroom, young people in Ecuador and Colombia turned to video tutorials to learn autonomously (González, 2018; Padilla *et al*., 2020). At university, video complemented textbooks and lecture notes (Qian *et al*., 2024) and supported out-of-class work in a flipped classroom model (Masero-Moreno, 2022) . However, quality does not always match quantity: many videos address measures of central tendency, but few explain when the median is preferable to the mean (Beltrán-Pellicer & Giacomone, 2021).

These findings are consistent with international evidence. In their meta-analysis, (Amalric *et al*., 2023) found that video produces greater benefits when it supplements existing teaching (g = 0.80) than when it replaces it (g = 0.28). In most studies in this axis, video also served as a supplement: it accompanied classes, textbooks, or out-of-class work. Nevertheless, these results should be interpreted with caution. A re-analysis of the data from Noetel *et al*. concluded that the benefits apply mainly to learning that requires lower-level cognitive processing and noted that pure mathematics contexts were not represented in that review (Trenholm & Marmolejo-Ramos, 2024). Moreover, several studies in this axis measured students' perceptions rather than their learning. Among them, (Rodríguez-Bravo *et al*., 2021) compared an experimental group with a control group, a design that allows the improvement to be attributed more firmly to the use of video.

The autonomous use of tutorials described by (Padilla *et al*., 2020) is consistent with what Mexican engineering students reported about the julioprofe channel: for them, the mathematical help available on YouTube is always accessible, private, and adapted to their own pace (Triviño-Cabrera *et al*., 2021) This agreement suggests that YouTube fulfills a support function outside the classroom that formal teaching does not always cover.

Axis 2. The teacher's role in selecting and creating videos

Eight studies focused on the teacher. Regarding the selection of videos, YouTube contains high-quality mathematics resources (Pattier, 2022) , but identifying them requires training: the assessments of mathematics videos made by 61 pre-service teachers were generally imprecise (Burgos & Castillo, 2022) . Two studies analyzed YouTube as a teaching tool. One described a channel that combines the traditional whiteboard with animations, infographics, and augmented reality (Shoufan & Mohamed, 2022) , and another showed that project-based learning with YouTube had a positive influence on the

acquisition of mathematical knowledge in primary education (del Valle-Ramón *et al*., 2020).

In teacher training, pre-service mathematics teachers built knowledge about teaching through interactions around videos (Triviño-Cabrera *et al*., 2021) , and the convergence of social networks and video opened new training opportunities (Vital-Rumebe *et al*., 2021c) . Finally, two studies addressed the creation of videos: learning progressions help to design activities that build on prior knowledge (Ezquerra *et al*., 2019) , and working with video enables students to learn by doing.

The warning about video quality is consistent, who analyzed the 150 most-viewed English-language mathematics explanation videos on YouTube. Most were mathematically correct, but for each topic more than half merely described the steps of a procedure without explaining the meaning of the concepts. Teacher training is therefore decisive. The same authors of the study on pre-service teachers later showed that a specific training intervention can change this picture: after it, most of 61 pre-service teachers made appropriate assessments of the didactic suitability of the videos, although not all of them were able to propose concrete improvements.

Axis 3. The historical context and the pandemic

Two studies provided the context for these findings. Audiovisual materials became more common and accessible over time, and educational programs adapted to them. During the COVID-19 pandemic, these resources played an exceptional role in virtual education.

The pandemic accelerated the use of these resources, but their benefit depends on access to technology. In Ecuador, in July 2025, 58.7% of rural households had internet access, compared with 76.6% of urban households, and only 16.2% of rural households had a computer or tablet (INEC, 2025). Therefore, promoting the use of YouTube without addressing these gaps could widen inequalities in mathematics learning.

Cross-cutting findings

Three conditions appeared across several axes. The first is the teacher's mediation, which students considered irreplaceable. The second is the quality of the content, which varies across videos and does not always address the meaning of concepts. The third is teacher training to select and critically analyze these resources.

Answers to the research questions

Regarding the first question, on the relationship between the use of YouTube and its applicability in the educational setting, the studies show that YouTube and educational videos are applied at all levels, from primary school to university and teacher training, and in different modalities: in the classroom, in blended teaching, in the flipped classroom, and in autonomous learning. Their applicability depends, however, on the teacher integrating them with a clear didactic purpose.

Regarding the second question, on YouTube's contribution to mathematics education, its main contribution is complementary: video allows students to review procedures at

their own pace, supports autonomous learning, and can increase students' interest. It also offers teachers a resource for their own training and for creating materials.

Regarding the third question, on whether YouTube is a valid and reliable medium for developing learning processes, the evidence reviewed does not support the claim that YouTube is reliable in itself. The quality of the videos is uneven, and many explain procedures without addressing the meaning of concepts. YouTube is a valid supplement when teachers select videos using criteria of didactic suitability.

Strengths and limitations

As a strength, this review brings together in a single study the Spanish-language literature on the use of YouTube in mathematics teaching, which was scattered across different educational levels and countries, and organizes it into axes that are useful for teaching practice.

The review also has limitations that should be considered when interpreting its results. First, the exact search date, the filters, and the number of records per database were not recorded, and one of the sources, Google Scholar, does not allow reproducible searches. Second, a single reviewer carried out the selection and thematic classification, and the methodological quality of the studies was not assessed. Third, all included studies were published in Spanish and the study period ends in 2022, so the review does not capture literature in other languages or the most recent publications. Fourth, some included studies address educational video in general rather than mathematics specifically. Finally, the heterogeneity of the designs prevented a meta-analysis.

Implications and future research

For practice, the results suggest three actions: including the analysis of the didactic suitability of videos in teacher training, creating institutional repositories of videos selected with explicit criteria, and using video as a supplement to classes rather than as a substitute for the teacher. For research, it is recommended to update this review with a reproducible search, to conduct studies with control groups in the Ecuadorian context, to measure learning and not only perceptions, and to analyze how gaps in access to technology affect the use of these resources.

CONCLUSIONS

This systematic review analyzed the influence of YouTube videos on the teaching and learning of mathematics based on 20 studies published between 2020 and 2022. The literature reviewed focuses on two topics: the video as a learning tool, which accounts for half of the studies, and the teacher's role in selecting and creating videos, which accounts for 40%. The remaining 10% addresses the historical context of educational video and its use during the pandemic.

YouTube videos support mathematics learning when they supplement teaching, not when they replace it. They allow students to review procedures at their own pace, support autonomous learning outside the classroom, and can increase interest in the subject. However, several of the studies reviewed measured the perceptions of students and

teachers, and only some compared their results with a control group; therefore, the evidence on the effect of YouTube on academic performance is still limited.

YouTube is not, in itself, a reliable medium for learning mathematics. The quality of the videos is uneven, and many merely describe the steps of a procedure without explaining the meaning of the concepts. Consequently, its validity as a learning resource depends on teachers selecting videos according to explicit didactic criteria.

The teacher plays an irreplaceable role in the educational use of YouTube. Teacher mediation gives meaning to the video within the teaching process, and teacher training is decisive: pre-service teachers find it difficult to assess the didactic quality of mathematics videos, but this ability improves with specific training. Strengthening the digital and didactic competence of teachers is therefore a condition for making good use of this resource.

In the Ecuadorian context, the use of YouTube for learning mathematics depends on access to the internet and to devices, which is still lower in rural households than in urban ones. Promoting the use of this resource without reducing this gap could widen educational inequalities. Studies with control groups in Ecuadorian educational institutions that measure students' learning, and not only their perceptions, are needed.

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