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THE EFFECTIVENESS OF SCRATCH INTERACTIVE MEDIA IN MATHEMATICS LEARNING: A LITERATURE REVIEW STUDY

Indah Febi Azhari[1*], Olivia Octavianti[2]

[1,2] IKIP Siliwangi, Jl. Terusan Jendral Sudirman, Cimahi, Provinsi Jawa Barat, Indonesia
[1]ifebia01@gmail.com, [2] oliviaoctavianti6@gmail.com

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ABSTRACT

This research aims to systematically review the specific effectiveness of utilizing Scratch interactive media in enhancing the quality of mathematics learning processes. This improvement in quality is examined through its impact on student learning outcomes and interactive experiences.The methodology employed is a Systematic Literature Review (SLR). This process was designed to comprehensively identify, critically evaluate, and interpret all available empirical evidence concerning the effectiveness of mathematics learning media that leverage Scratch. The initial search procedure successfully gathered a total of 40 articles from various trusted scientific databases. The studies considered were restricted to publications released within the timeframe of 2020 to 2025. After undergoing a rigorous screening process applying predefined inclusion and exclusion criteria based on topic relevance and study methodology it was determined that 21 eligible articles were selected for in-depth analysis. This analysis focused on both the quantitative and qualitative results regarding Scratch's effectiveness. The findings from the systematic review consistently indicate that the use of Scratch provides a significant impact on improving the quality of mathematics learning. Specifically, Scratch successfully transforms the learning process into one that is more interactive and engaging, which, in turn, effectively enhances students' cognitive abilities, including conceptual understanding and problem-solving skills. These results affirm Scratch as a valid and effective pedagogical innovation with great potential for wider integration into the mathematics curriculum in the digital age.

Corresponding Author:
Indah Febi Azhari,
IKIP Siliwangi
Cimahi, Indonesia
ifebia01@gmail.com

Penelitian ini bertujuan untuk melakukan tinjauan sistematis terhadap efektivitas spesifik penggunaan media interaktif Scratch dalam meningkatkan kualitas proses pembelajaran matematika. Peningkatan kualitas ini dievaluasi melalui dampaknya terhadap hasil belajar siswa dan pengalaman interaktif mereka. Metodologi yang digunakan adalah Tinjauan Literatur Sistematis (SLR). Proses ini dirancang untuk mengidentifikasi, mengevaluasi secara kritis, dan menafsirkan secara komprehensif semua bukti empiris yang tersedia mengenai efektivitas media pembelajaran matematika yang memanfaatkan Scratch. Prosedur pencarian awal berhasil mengumpulkan total 40 artikel dari berbagai basis data ilmiah tepercaya. Studi yang dipertimbangkan dibatasi pada publikasi yang dirilis dalam rentang waktu 2020 hingga 2025. Setelah melalui proses penyaringan yang ketat dengan menerapkan kriteria inklusi dan eksklusi yang telah ditentukan sebelumnya berdasarkan relevansi topik dan metodologi penelitian diputuskan bahwa 21 artikel yang memenuhi syarat dipilih untuk analisis mendalam. Analisis ini berfokus pada hasil kuantitatif dan kualitatif mengenai efektivitas Scratch. Temuan dari tinjauan sistematis secara konsisten menunjukkan bahwa penggunaan Scratch memberikan dampak signifikan terhadap peningkatan kualitas pembelajaran matematika. Secara khusus, Scratch berhasil mengubah proses pembelajaran menjadi lebih interaktif dan menarik, yang pada gilirannya secara efektif meningkatkan kemampuan kognitif siswa, termasuk pemahaman konseptual dan keterampilan pemecahan masalah. Hasil ini menegaskan bahwa Scratch merupakan inovasi pedagogis yang valid dan efektif dengan potensi

besar untuk diintegrasikan secara lebih luas ke dalam kurikulum matematika di era digital.

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INTRODUCTION

Mathematics is often considered a difficult subject that students are not very interested in. Mathematics is one of the causes of learning anxiety. Utami & Warmi, (2019) revealed that learning difficulties based on anxiety during mathematics lessons are often experienced by students, making it difficult for students who experience learning difficulties based on mathematical anxiety to understand mathematics lessons at school. This situation is very unfortunate because mathematics is a subject that students should master at school, and there are also many applications of mathematics in real life.

Students often find mathematics boring and unpleasant, and some even say that mathematics is scary and difficult to understand. In line with the research by Aminullah & Irwansya (2024) students stated that learning mathematics is difficult and boring because teachers only explain on the blackboard and students only need to take notes. However, since using technology, students feel that learning is more interesting, so they are more interested in finding out about the material being discussed and better understand the problems. Previous research conducted by Miartini, Roza, dan Heleni (2023), shows that the use of technology can improve students' mathematical comprehension skills. Students stated that the use of technology was very helpful because they could repeat the desired material, making it easier to understand further material. By utilizing technological advances, students are able to apply complex mathematical concepts into visual objects that are easier to understand.

The difficulty of mathematics stems from its highly abstract nature, which differs from other sciences whose objects of study can be easily visualized. According to research by Afifa et al., (2023), difficulties in learning mathematics arise due to several factors, namely internal and external factors, with internal factors having a greater influence, namely physiological and psychological factors. Psychology consists of intelligence, talent, interest, motivation, mental health, and student types. Many concepts in mathematics, such as algebra, functions, variables, and others, can only be understood through imagination and high-level reasoning. Students often find it difficult to build a bridge between mathematical notation and the meaning behind it. This often causes students to simply memorize procedures without understanding the underlying basic concepts and methods. This often occurs because the teaching methods used by teachers do not provide active learning experiences and are too teacher-centered. As a result, students' motivation and conceptual understanding of mathematics learning can decline.

According to Ilyas & Syahid (2018) in the world of learning methodology, the presence of teachers as educators is very important as they are the most important part of implementing the teaching and learning process in formal education, as is the case in education. Teachers are the driving force in applying learning methodologies to students. Therefore, teachers as educators must understand and comprehend learning methodologies so that they can truly provide education and learning to students in accordance with the applicable regulations regarding teacher competencies.

In addition to learning methods, the development of digital technology also plays a significant role in students' understanding of mathematics. The integration of interactive media in the learning process is necessary to create learning that is more interesting, effective, and relevant to today's life. Interactive media can make students more focused on the material being discussed and increase their curiosity. Students become more active in asking questions when there are problems or parts that are not well understood (Payadnya et al. 2024). Interactive media not only allows students to receive information, but also provides a way to interact, experiment, and visualize difficult concepts.

Technology plays a significant role in replacing traditional media in mathematics learning, as it is simpler and does not require many materials. Technology can also be used to stimulate and facilitate the learning process, enabling the creation of interactive learning media so that students can better understand mathematical concepts that can be visualized with more conceptual objects. It is undeniable that in the 21st century, teachers and students must be proficient in using technology. Chyquitita, (2024) states that today's professional teachers must be able to develop and adapt to rapid and rapid technological developments.

In addition, technology is also a valuable tool for teachers to create interactive learning media that aims to increase students' motivation, participation, and understanding of mathematics in the learning process. Considering that mathematics is a science based on information and understanding of everyday problems, technology that can produce interactive learning media can help students build a strong conceptual understanding related to everyday problems. (Yulianti, 2024).

According to the results of research by Kusumawati et al (2021) interactive learning media can motivate students in mathematics learning. Interactive learning media can clarify the material because it is equipped with interesting objects so that students can learn the material more easily. In addition, it can train students' abilities after learning the material because they can try various activities available on the interactive learning media related to the material being studied.

Scratch is one platform that can be used to create interactive learning media in mathematics education. Scratch is a visual programming language that allows users to create interactive stories, responsive games, and animations that can be shared via the internet (Praja et al, 2025). Scratch greatly supports learning, especially for understanding concepts, because it can convert programming logic to create applications, animations, and games that are interesting for mathematics learning. Previous research conducted by Ardiyanti & Tyas (2025), shows that the use of interactive learning media based on Scratch can increase students' desire to learn, making them more eager to understand the material being taught, thereby improving their learning outcomes. In addition, there were no negative responses from teachers or students regarding the use of Scratch in the learning process.

Based on the above, the author is interested in reviewing various relevant literature studies on the use of interactive media scratch in mathematics learning. A literature study is considered appropriate for understanding the various theories and concepts related to the use of interactive media, the concept of Scratch, and mathematics learning. It is hoped that the findings from this literature study can provide an overview of effective strategies for helping students understand mathematical concepts through the use of interactive media such as Scratch.

METHOD

This type of literature research uses Systematic Literature Review (SLR). According to Triandini et al (2019) this method is carried out by identifying, reviewing, evaluating, and interpreting all available research. Data collection for the literature study was carried out by searching for articles on Google Scholar, Sinta, and several other sources. The researchers limited the number of articles to 40 from 2020 to 2025. Then, the researchers filtered and analyzed the articles through a selection process. After the analysis, the researchers found 21 articles that met the predetermined criteria.

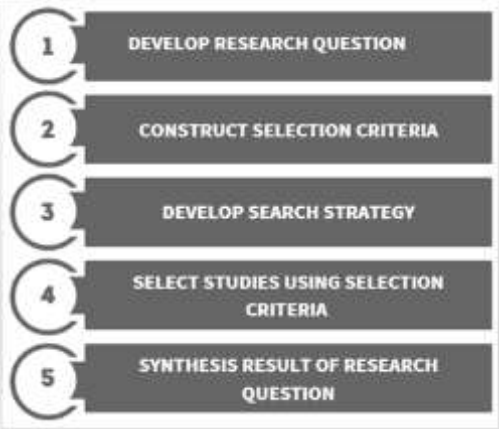

Figure 1. Research Procedure Design for Systematic Literature Review

Based on the chart above, the researcher conducted the review using articles relevant to the research question. The process was carried out in several stages. In the initial stage, the researcher formulated the articles to be searched and then compiled the selection criteria. The criteria selected were specific, such as the types of studies/literature that could and could not be included in the review. After that, the researcher searched for and compiled article criteria according to the keywords used, namely the theme "Development of Scratch Interactive Media in Mathematics Learning," then the researcher selected studies relevant to the theme. In the final stage, the selected study data were extracted, analyzed, and combined (synthesized).

RESULTS AND DISCUSSION

Result

The results of the analysis of several research articles on the effectiveness of interactive scratch media in mathematics learning from various journals taken from Google Scholar, Sinta, and other journals. The initial search yielded 40 articles, which were then selected based on their titles, content and discussion, and conclusions regarding the focus of the study. After selection, the researchers obtained 21 relevant articles. For more details, see the table below:

Table 1. Effectiveness of Scratch Interactive Media in Mathematics Learning

No	Author Name	Year	Method	Learning Evaluation
1	Aulia et al.	2021	Quantitative description	• Students' interest in learning mathematics in trigonometry • Student response to the use of Scratch in learning

2	Praja et al	2025	Multimedia Development Life Cycle	• The use of scratch has great potential to encourage student collaboration. • Students responded positively to the media created
3	Ardiyanti & Tyas	2025	*Research and Development*	• The development of Shape Safari learning media assisted by the Scratch platform on the subject of flat shape characteristics is considered very feasible
4	Sunarto	2025	*Research and Development*	• The developed media can improve students' mathematics learning outcomes
5	Kirana et al	2025	*Quasi Experimental Design*	• Scratch-based learning media on flat shape area material is considered valid in terms of appearance, programming, content/material, learning, and language
6	Septorini	2025	*Research and Development*	• Teachers and students responded positively to this learning medium
7	Yulastari et al	2025	*Research and Development*	• The developed media can improve student learning outcomes
8	Alvionita et al	2025	Quasi Eksperimental	• The use of Scratch-based digital learning media has increased students' interest in learning
9	Setyoningtyas	2024	*Research and Development*	• Students' interest in learning increased significantly after using the developed media
10	Andarini & Fajrie	2024	*Research and Development*	• The development of Scratch-based teaching media in fraction concept material is considered feasible, practical, and effective
11	Kusumastuti & Ghufron	2025	Studi Kasus	• Students' understanding of fractions also improved compared to before using Scratch-based teaching media

12	Khalil & Wardana	2022	*Research and Development*	• The developed scratch media has been proven valid for use in mathematics learning processes in schools
13	Nurhayati et al	2023	*Research and Development*	• The results of the evaluation of students' understanding of the concepts also show that this media is suitable for use in the mathematics learning process
14	Fadila & Ramadhani	2024	*Research and Development*	• Scratch media is suitable for use, practical, and can be used as teaching material for mathematics
15	Setiawati, Suweken, & Suparta	2025	*Research and Development*	• Successfully encouraged students to discover concepts and explore knowledge of geometric transformations through Scratch • Students can relate learning to context or everyday life
16	Fitriani & Yahfizham	2024	Studi Literatur	• The use of Scratch helps elementary school students think computationally • Helping students solve problems and think creatively • The use of scratch motivates students in learning mathematics and computational thinking
17	Octavia, Usdiyana, & Sudihartinih	2025	*Research and Development*	• Helping students engage in mathematics learning • Scratch makes learning statistics more fun
18	Luthfiyyah et al.	2023	Penelitian Eksperimen	• Scratch has been proven to significantly increase student engagement and motivation during mathematics lessons
19	Rokhmaniyah	2025	*Research and Development*	• The implementation of scratch in teaching fractions to second-grade elementary school students has been proven effective in improving conceptual understanding

20	Ulkhasanah, Dewi, & Defitriani	2025	*Quasi Experimen*	• Learning with a computational thinking approach and Scratch assistance can significantly improve students' mathematical problem-solving skills
21	Widiyanti & Desniarti	2025	*Research and Development*	• Scratch-assisted LKPD and the use of problem-based learning models can improve students' mathematical problem-solving skills • Scratch-assisted LKPD is considered valid and its practicality is also considered valid

Various research findings indicate that the use of Scratch-based learning media has a highly positive impact on mathematics education. This medium has been shown to significantly increase students' interest and motivation to learn, as well as encourage active engagement, collaboration, and positive responses from both students and teachers. In terms of quality, Scratch-based media is considered valid, practical, and suitable for use because it meets standards in terms of presentation, programming, content, pedagogy, and language. Furthermore, its use is effective in improving learning outcomes and understanding of mathematical concepts, such as in topics involving plane figures, fractions, statistics, and geometric transformations. This approach also supports the development of computational thinking, problem-solving skills, and student creativity, while helping them connect learning to real-life contexts. Thus, Scratch-based learning media can serve as an effective and innovative alternative to enhance the quality of mathematics education.

Discussion

Based on the results of the identification and 20 articles reviewed above, the use of interactive Scratch media in mathematics learning significantly improves students' abilities. Students find it easier to understand the material and are enthusiastic about learning mathematics. The evaluation results also show that the Scratch media developed in the research by Khalil & Wardana (2022), is suitable for use in the mathematics learning process in schools, with an average effectiveness score of 95.00 in the categories of highly practical, valid, and proven effective in improving HOTS. This is in line with the research by Chaerunnisa & Bernard, (2021). Mathematics learning using interactive Scratch media is more interesting than using conventional teaching media. Student interest in learning at the school increased in the strong category.

In the research results of Rahadi & Ismiyati, (2024) Scratch-assisted mathematics learning media is classified as highly valid, practical, and effective. The use of Scratch-based mathematics learning can help motivate students to learn. This is also in line with the research by Qodariah & Rabbani, (2022). Scratch-assisted learning media influences the understanding of mathematical concepts, as proven by the results of the pretest and posttest, and Scratch-assisted learning has a positive response and is quite effective.

When combined with the right learning approach or model, Scratch can also significantly improve students' cognitive abilities, as stated in a study by Ulkhasanah, Dewi, & Defitriani, (2025), which found that learning with a computational thinking approach using Scratch significantly improved students' mathematical problem-solving skills. although there were obstacles during the implementation of learning, where most students were not familiar with the Scratch application, so that learning time was reduced because at the beginning they had to be introduced to the Scratch application first. Research by Widiyanti & Desniarti, (2025) also shows that the use of teaching materials in the form of worksheets with the help of Scratch and the problem-based learning model can improve students' mathematical problem-solving skills. Students also stated that worksheets with the help of Scratch are considered practical and easy to use for mathematics learning. This is in line with the literature review conducted by Jannah, Fitriyana, & Nugroho, (2024) which found that using Scratch to support an appropriate learning model can significantly improve students' cognitive abilities.

Overall, Scratch media successfully created interactive and engaging learning experiences, and also broke down students' initial perception that games in mathematics are not fun. Its proven effectiveness and practicality show that Scratch is a valid teaching tool that can improve the quality of learning media, influence student understanding, and have a direct positive impact on their learning outcomes. Thus, this media can be effectively implemented to encourage students to actively contribute during learning.

CONCLUSION

Scratch-based learning media has consistently demonstrated high validity, practicality, and effectiveness in improving the quality of mathematics learning. The results of the study confirm that Scratch has succeeded in transforming monotonous learning processes into interactive, engaging, and more lively ones, thereby significantly increasing students' interest, motivation, and involvement in learning. The effectiveness of this media is achieved through interactive visualizations and animations that can weigh understanding and difficult concepts such as trigonometry, angles, and operational calculations.

Furthermore, the use of Scratch has a tangible positive impact on students' academic outcomes and thinking skills. This medium not only improves learning outcomes and conceptual understanding, but is also effective in developing students' Higher Order Thinking Skills (HOTS) and problem-solving abilities. Thus, Scratch is highly recommended as a proven teaching aid for creating a constructive mathematics learning environment that encourages collaboration and creativity, and achieves optimal educational goals.

Our research has limitations that readers should be aware of, such as limited access to reputable journals, and the fact that most studies focus on the effectiveness of scratch at the elementary school level. The representation of studies at the middle or high school levels may be lacking, so that the generalization of findings about Scratch for all levels is limited. Given the significant impact of learning, the author suggests the need to develop innovative and interactive learning media such as Scratch in other studies.

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