

Jurnal JTik (Jurnal Teknologi Informasi dan Komunikasi)

DOI: <https://doi.org/10.35870/jtik.v9i4.4111>

Systematic Literature Review on the Effectiveness of Multimedia in Flipped Learning Classrooms

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article info

Article history:

Received 20 March 2025

Received in revised form

20 April 2025

Accepted 1 May 2025

Available online October 2025.

Keywords:

Flipped Learning; Educational

Multimedia; Student

Engagement; Comprehension;

Systematic Review.

Kata Kunci:

Pembelajaran Terbalik;

Multimedia Pendidikan;

Keterlibatan Siswa;

Pemahaman; Tinjauan

Sistematis.

abstract

This study addresses a critical gap in flipped learning research by focusing on the specific role of multimedia tools in enhancing student engagement and comprehension—an area often overlooked in prior studies that tend to generalize the benefits of flipped classrooms. Employing a Systematic Literature Review (SLR) methodology, the study adheres to PRISMA guidelines and analyzes 20 empirical studies selected from 147 initial records obtained through databases such as Scopus, Google Scholar, and PubMed. Articles were included based on relevance, publication year (2019–2024), and methodological rigor. The findings quantitatively indicate that 100% of the studies reported improved comprehension, 90% observed heightened engagement, and 80% noted enhanced learning flexibility through multimedia-supported flipped learning. However, 60% of the studies identified infrastructural and digital literacy challenges as significant barriers. Theoretically, this research reinforces Vygotsky's social constructivism by emphasizing interactive and student-centered learning environments. Practically, it underscores the need for teacher training and robust digital infrastructure to optimize flipped learning implementation. This review contributes actionable insights into designing more adaptive, technology-integrated education systems.

abstrak

Studi ini membahas kesenjangan kritis dalam penelitian pembelajaran terbalik dengan berfokus pada peran khusus alat multimedia dalam meningkatkan keterlibatan dan pemahaman siswa area yang sering diabaikan dalam studi sebelumnya yang cenderung menggeneralisasi manfaat kelas terbalik. Dengan menggunakan metodologi Tinjauan Literatur Sistematis (SLR), studi ini mematuhi pedoman PRISMA dan menganalisis 20 studi empiris yang dipilih dari 147 catatan awal yang diperoleh melalui basis data seperti Scopus, Google Scholar, dan PubMed. Artikel dimasukkan berdasarkan relevansi, tahun publikasi (2019–2024), dan ketelitian metodologis. Temuan secara kuantitatif menunjukkan bahwa 100% studi melaporkan peningkatan pemahaman, 90% mengamati peningkatan keterlibatan, dan 80% mencatat peningkatan fleksibilitas belajar melalui pembelajaran terbalik yang didukung multimedia. Namun, 60% studi mengidentifikasi tantangan infrastruktur dan literasi digital sebagai hambatan yang signifikan. Secara teoritis, penelitian ini memperkuat konstruktivisme sosial Vygotsky dengan menekankan lingkungan belajar yang interaktif dan berpusat pada siswa. Secara praktis, hal ini menggarisbawahi perlunya pelatihan guru dan infrastruktur digital yang kuat untuk mengoptimalkan penerapan pembelajaran terbalik. Tinjauan ini memberikan wawasan yang dapat ditindaklanjuti dalam merancang sistem pendidikan yang lebih adaptif dan terintegrasi dengan teknologi.

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ACM Computing Classification System (CCS)

 EBSCOhost

Communication and Mass Media Complete (CMC)

1. Introduction

Currently, the education sector faces significant challenges in improving learning effectiveness. Traditional teaching methods, which rely on direct interaction between teachers and students, often fail to encourage active student engagement in the learning process. One widely adopted solution is the implementation of flipped learning, an approach where students study materials at home first and then use class time for discussions or more interactive tasks (Sadeghi *et al.*, 2020). In this context, multimedia tools have been found to be highly supportive of the flipped learning process, providing students with flexible access to learning materials through videos, applications, and other interactive tools. In their study, Bergmann & Sams (2012) stated that the flipped classroom shifts the responsibility of learning from teachers to students, thereby enhancing active engagement through multimedia resources. Moreover, the combination of online activities and face-to-face discussions creates a collaborative environment in which students feel more confident participating because they have prepared the material in advance.

Research also reveals that the implementation of multimedia-assisted learning in flipped classrooms significantly enhances the learning autonomy of EFL (English as a Foreign Language) students. The majority of participants (73%) reported that this learning model fosters independence, allowing them to access materials such as videos, LMS, and online resources flexibly before face-to-face sessions (Aprianto *et al.*, 2020). However, despite many studies supporting the effectiveness of flipped learning in improving student comprehension, several challenges remain. Literature shows that while flipped learning can enhance student engagement and motivation, its implementation is not always smooth. Key challenges include time management difficulties, limited access to adequate technology, and teachers' struggles in designing appropriate multimedia materials (Aprianto *et al.*, 2020). Additionally, while many studies discuss the general benefits of flipped learning, few specifically examine the impact of multimedia tools in improving learning quality within this context. The primary objective of this study is to explore the impact of

multimedia tools in supporting flipped learning in classrooms. This research aims to assess how effective multimedia tools are in enhancing student comprehension and engagement, as well as to compare them with traditional teaching methods. Furthermore, the study will examine how multimedia tools can make learning more interactive and adaptive, along with the challenges faced in their implementation (Fasli, 2021). By focusing on the role of multimedia tools in improving student learning experiences, this research will provide new insights into how technology can support flipped learning-based education. The relevance of this study is significant, given the need to continuously develop and refine teaching methods to align with technological advancements and modern educational needs. Moreover, with the increasing use of technology in education, it is essential to understand how multimedia tools can be effectively utilized in flipped learning to enhance student learning outcomes. This study is expected to contribute to a better understanding of the application of flipped learning and multimedia tools in improving student learning experiences across various educational contexts (Upadhyaya, 2023).

Multimedia tools in education refer to the use of technology that combines various media elements such as text, images, videos, audio, animations, and interactivity to support the teaching and learning process (Krstić, 2021). These tools can be presented in various forms, facilitating more dynamic and engaging learning experiences. Thus, multimedia tools serve not only as sources of information but also as instruments that support deeper and more interactive student engagement. Previous research indicates that multimedia use can enhance student motivation and comprehension by providing more engaging and accessible learning experiences (Ye, 2024). Multimedia tools can be categorized based on their function in education. According to research, they can be divided into two main categories: computer-based software that enables the creation of interactive content, and hardware that supports the delivery of audiovisual materials (Turibius *et al.*, 2023). This categorization includes various devices, from interactive learning applications and instructional videos to multimedia presentation tools like PowerPoint and Google Classroom. Each category

serves different purposes, from improving student understanding of materials to supporting collaborative activities in the classroom. Flipped learning is a teaching model that reverses the traditional structure, where students study materials digitally outside the classroom and then use class time for discussions and practical tasks (Sukerti *et al.*, 2020). This model allows students to learn independently through online materials, while class time is focused on group discussions and more interactive practices. The flipped learning concept has proven effective in deepening students' understanding of materials studied independently before class sessions (Jdaitawi *et al.*, 2022).

Flipped learning can be categorized into two main models: the flipped classroom and the full flipped learning model. The flipped classroom focuses on using technology to shift traditional learning to online formats before class, while the full flipped learning model involves more intensive and interactive in-class learning, enabling students to collaborate more actively with more complex technology-based teaching (Mei, 2021). Each model has distinct characteristics that can be tailored to the needs and goals of teachers and students. The learning classroom refers to an environment designed to support interaction between students and teachers, as well as among students themselves, to achieve set educational goals (Vagg *et al.*, 2020). This environment encompasses not only physical spaces but also digital and technological components that facilitate such interactions. In today's digital era, learning classrooms increasingly utilize technology-based tools that enable remote communication and collaboration, as seen in applications like Google Classroom and Zoom. Learning classrooms can be categorized into several models, including traditional face-to-face classrooms, hybrid classrooms combining online and in-person elements, and fully online classrooms that allow students to learn independently using digital tools (Sharda & Bajpai, 2021). Each category offers flexibility in how learning is delivered, providing students with options to choose methods that best suit their learning styles.

2. Research Methodology

This study focuses on the use of multimedia tools in flipped learning classrooms and their impact on learning quality. The observed phenomena include the application of multimedia tools in educational contexts to enhance student interaction and more effective teaching through technology in flipped learning. Although flipped learning has been recognized for improving learning outcomes, this study identifies implementation challenges, such as limitations in managing technological resources and teachers' readiness in designing multimedia-based materials. This study employs the Systematic Literature Review (SLR) method to examine existing literature on the application of multimedia tools in flipped learning. Primary data sources include scholarly journals, articles, and books relevant to multimedia tools and flipped learning. Secondary data sources involve literature addressing learning concepts related to flipped learning, educational technology, and multimedia use in classrooms. SLR is a structured approach to synthesizing comprehensive evidence by following strict protocols, such as inclusion and exclusion criteria.

This study is grounded in Lev Vygotsky's (1978) social constructivism theory, which emphasizes the importance of social interaction in the learning process, where understanding and knowledge are built through conversation and collaboration among individuals. This concept is highly relevant to flipped learning, which relies on student collaboration and discussion in studying materials before class sessions. The theory also underpins the use of multimedia tools in teaching as a means to facilitate social and interactive processes in education. The study follows rigorous SLR procedures. The first stage involves formulating clear and focused research questions. Next, researchers develop a research protocol that includes search strategies, inclusion and exclusion criteria, and data analysis methods. Literature searches are conducted across electronic databases such as Google Scholar, PubMed, and Scopus using predetermined keywords. After identifying relevant literature, researchers assess study quality using established criteria, such as relevance, methodological quality, and contribution to the research topic.

The final stage involves data extraction and systematic analysis of results. In line with the SLR approach, the initial step in this study is to explicitly and systematically formulate research questions. These questions aim to guide the search, screening, and analysis of literature to produce relevant syntheses that contribute to the research objectives.

Focusing on the impact of multimedia use in flipped learning, the following research questions are formulated to guide the investigation of student engagement, material comprehension, and implementation challenges and opportunities. These questions are summarized in Table 1.

Table 1. Research Questions in the Systematic Review

No	Research Question	Objective
1	How does the use of multimedia tools impact student engagement in flipped learning?	To identify the extent to which multimedia enhances student participation.
2	To what extent does multimedia use in flipped learning improve student comprehension of learning materials?	To assess the effectiveness of multimedia in supporting material understanding.
3	How does multimedia-based flipped learning create interactive and adaptive learning experiences?	To illustrate multimedia's contribution to learning interactivity.
4	What are the main challenges in implementing multimedia-based flipped learning in classrooms?	To uncover implementation barriers from technical and pedagogical perspectives.
5	How does the flipped learning model with multimedia support flexibility and student learning independence?	To explore multimedia's role in creating flexible learning.

These five research questions reflect the focused direction of this study. Questions 1 and 2 measure the effectiveness of multimedia tools in enhancing engagement and comprehension, two key indicators of learning quality. Meanwhile, questions 3 to 5 expand the scope to aspects of interactivity, flexibility, and implementation challenges of multimedia-based flipped learning. By referring to these questions, the identification, selection, and

analysis of literature become more structured and directed in addressing key issues in 21st-century digital learning practices. The following inclusion and exclusion criteria are used to filter relevant literature in this systematic review. These criteria ensure that only studies aligned with the research focus are included in further analysis.

Table 2. Inclusion and Exclusion Criteria in the Study

Aspect	Inclusion Criteria	Exclusion Criteria
Publication Type	Indexed scholarly journal articles and academic conference proceedings	Opinions, popular articles, blogs, or non-scholarly sources
Publication Year	Published between 2019–2024	Published before 2019
Language	English or Indonesian	Languages other than English and Indonesian
Topic	Discusses flipped learning and multimedia use in education	Irrelevant to flipped learning or does not discuss multimedia use
Population	Focuses on primary, secondary, or higher education students	Focuses on teachers, administrators, or non-student populations
Study Type	Quantitative, qualitative, or mixed empirical research	Literature reviews without empirical data or purely theoretical studies

After determining the research questions and applying the inclusion and exclusion criteria, the next step in the SLR approach is the identification,

selection, and evaluation of relevant literature. This process is conducted systematically following the Preferred Reporting Items for Systematic Reviews

and Meta-Analyses (PRISMA) guidelines, enabling researchers to transparently and systematically trace and filter sources. The PRISMA flow diagram below outlines the stages of literature selection, starting from initial searches, screening, feasibility evaluation, to final study inclusion for analysis.

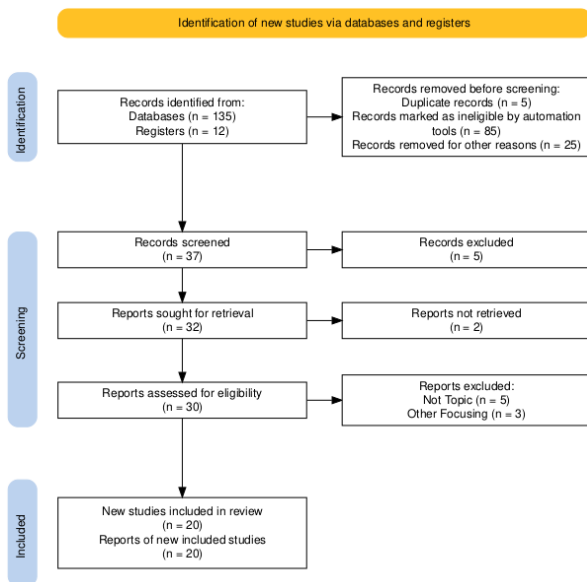


Figure 1. PRISMA Flow Diagram

The study identification process begins with literature searches through two main sources: databases (135 articles) and additional bibliographies or registries (12 articles), totaling 147 records. During initial screening, 115 records were eliminated due to duplicates (5 records), irrelevance based on automated filters (85 records), or other reasons (25

records). After screening, 37 records remained for further evaluation. In the screening stage, 5 records were removed due to title mismatch. Of the 32 reports pursued for full access, 2 were unavailable. From the 30 fully obtained reports, feasibility assessments were conducted, and 8 reports were excluded from final analysis due to topic mismatch (5 reports) or differing focus (3 reports). Ultimately, 20 studies were included in the systematic review and further analyzed in this research. In this study, content analysis is used to identify patterns, relationships, and key information in relevant literature. This process involves data processing to assess the diversity and interconnections among existing research findings. Content analysis enables researchers to synthesize findings from various studies into a comprehensive synthesis, yielding deeper insights into the impact of multimedia tools in flipped learning. To gain a comprehensive understanding of the contributions of multimedia tools in flipped learning, based on systematic searches of relevant studies selected via the PRISMA flow, these studies were chosen based on inclusion criteria focusing on multimedia use in flipped classrooms, student engagement, and learning outcome improvements. The analyzed literature reflects diverse approaches and findings that enrich the understanding of this teaching model's effectiveness. The table below summarizes selected articles, including titles, authors, publishers, publication years, and key findings related to student engagement and comprehension in multimedia-based flipped learning.

Table 3. Literature Review

Article Title	Author	Publisher	Year	Research Findings
Flipped Classroom Approach	S. H. Halili, N. Mohsin, R. Razak	Int. J. Web Based Learn. Technol. Teach.	2021	Flipped classroom with multimedia increases student motivation, learning, and engagement.
Evaluation on Student Engagement of Online Case-Based Learning and Flipped Learning During Covid-19 Pandemic	Marisa Karsen, D. M. Kristin, Harijanto Pangestu	International Conference on Information Management and Technology (ICIMTech)	2021	Online flipped learning and case-based learning enhance student engagement during the pandemic.
Flipped Learning Methodology in Professional Training of	I. Nikitova, S. Kutova, Tetiana Shvets, O. Pasichnyk, Vitaly Matsko	European Journal of Educational Research	2020	Flipped learning with multimedia improves language skills and

Future Teachers	Language			student learning preferences.
Unlocking the Power of Flipped Learning: Revolutionizing Science Education	I. Upadhyaya	Journal of Lumbini Engineering College	2023	Flipped learning enhances learning outcomes and student engagement in science education.
Flipped Classroom: An Investigation into Learner Engagement During Non-Face-to-Face Components	Kc Lee, H. Goh, Jessie Teng, Kah Wei Wong	Scholarship of Teaching and Learning in the South	2020	Students show active engagement in flipped classrooms, especially in tutorial preparation.
Students' Experience with Flipped Learning Approach in Higher Education	F. Zain, Siti Nazuar Sailin	Universal Journal of Educational Research	2020	Students report positive experiences with flipped learning, including active and collaborative learning.
The Enhancement of Student Learning Engagement in EFL Speaking Flipped Classrooms	Linling Zhong	Transactions on Social Science, Education and Humanities Research	2020	Flipped learning improves student engagement in EFL (English as a Foreign Language) learning.
The Impact of Flipped Learning on Engagement with the Learning Process in Pre-Licensure BSN Students	Carlo Parker	Iris Journal of Nursing & Care	2021	Flipped learning enhances student engagement and performance in nursing education.
Analysis of the Students' Engagement in the Process of Learning Mathematics Using a Flipped-Classroom Approach to Trigonometry	Maria Magdalena Yunika Nugraheni, Parmamita Suryaningrum, M. A. Rudito	Journal of Mathematics and Mathematics Education	2020	Flipped classroom increases student engagement in trigonometry learning.
Impact of a Heutagogical, Multimedia-Based Teaching Concept to Promote Self-Determined, Cooperative Student Learning in Clinical Radiology	U. Teichgräber, Maja Ingwersen, H. Mentzel, R. Aschenbach, Rotraud Neumann, T. Franiel, Aimée Herzog, J. Böttcher, A. Pfeil, B. Mensel, C. Kühnel, M. Freesmeyer, M. Fischer, Jan M. Zottmann	RöFo - Fortschritte auf dem Gebiet der Röntgenstrahlen	2023	Multimedia-based flipped classroom promotes independent and collaborative student learning.
E-Learning: Direct Effect of Student Learning Effectiveness and Engagement through Project-Based Learning,	M. Umar, Ilsang Ko	Sustainability	2021	Project-based learning and flipped learning enhance learning

Team Cohesion, and Flipped Learning during the COVID-19 Pandemic				effectiveness and student engagement.
Exploring Research Trends in the Implementation of the Flipped Classroom Model in Educational Research: A Review of Literature	Fırat Kilavuz	Pedagogical Research	2021	Bibliometric study shows growing research trends on flipped classrooms in education.
Revisiting The Flipped Classroom: Lessons Learned	M. A. Alarcon Fortepiani	The FASEB Journal	2021	Flipped classroom with online learning improves student engagement and academic achievement.
Student Engagement in Flipped Classroom in Nursing Education: An Integrative Review	Emily Ka Lai Ng	Nurse Education in Practice	2022	Flipped classroom enhances student engagement in nursing education, with mixed results for emotional engagement.
Student Engagement in Mathematics Flipped Classrooms: Implications of Journal Publications From 2011 to 2020	C. Lo, K. Hew	Frontiers in Psychology	2021	Flipped classroom improves student engagement in mathematics learning, with some cognitive engagement improvements.
Flipping Learning to Develop Students' Engagement and Achievement in the Computer Applications Unit as Part of Their Studies on the Subject of Instructional Design	A. Alodail	Journal of Educational and Psychological Studies [JEPS]	2020	Flipped learning enhances engagement and achievement in instructional design studies.
Implementing Flipped Classroom with Digital Students	Carlos Ankora	Journal of Educational Research and Practice	2020	Flipped classroom supports independent learning and student engagement in digital studies.
The Effects of the Regulated Learning-Supported Flipped	Hyojung Jung, S. Park, Hyun Song Kim, Jongchan Park	Journal of Computing in Higher Education	2022	Flipped learning supported by learning regulation

Classroom on Student Performance				improves students' cognitive skills.
Enhancing Online Instructional Approaches for Sustainable Business Education in the Current and Post-Pandemic Era: An Action Research Study of Student Engagement	Lui-Kwan Ng, C. Lo	Education Sciences	2022	Flipped classroom approach with gamification enhances student engagement in the post-pandemic era.
Transactional Distance Perceptions, Student Engagement, and Course Satisfaction in Flipped Learning: A Correlational Study	F. Yilmaz, Ke Zhang, A. Ustun, Ramazan Yilmaz	Interactive Learning Environments	2022	Students' transactional distance perceptions relate to engagement and satisfaction in flipped learning.

From the table, it is evident that most studies conclude that multimedia tools in flipped learning consistently have a positive impact on the learning process. These findings indicate that integrating visual, audio, and interactive elements enhances student attention as well as cognitive and affective engagement. Additionally, multimedia-supported flipped learning provides students with opportunities to explore materials independently before face-to-face sessions, allowing class time to focus on meaningful discussions and problem-solving. This trend reflects a paradigm shift toward more adaptive, collaborative, and technology-based learning models, aligning with the demands of 21st-century education.

3. Results and Discussion

Results

The literature review on multimedia tools in learning reveals that tools such as instructional videos and interactive learning applications significantly contribute to improving student engagement and comprehension. Several studies indicate that multimedia tools enhance learning effectiveness by providing easily accessible information in various formats (Fasli, 2021). Multimedia tools enable students to learn independently, with videos and digital resources accessible anytime and anywhere, supporting more flexible technology-based learning. The results show that multimedia tools not only support material comprehension but also encourage

active student engagement in the learning process. Fasli (2021) reveals that multimedia tools, when applied in flipped classrooms, allow students to learn independently before class, followed by discussions and practical applications in class. This strengthens active and deep learning, giving students opportunities to develop critical and creative skills through technology use. This suggests that multimedia tools serve as a bridge between individual learning and social interaction in the classroom. The description and explanation of this data refer to the problem addressed in this study: the limitations of traditional teaching methods in fostering active student engagement.

The use of multimedia tools in flipped learning can be an effective solution to this problem, as it allows students to learn independently with digitally provided materials accessible anytime. This is relevant to the issues identified in this review, where traditional teaching often fails to respond to students' needs for active engagement and deeper comprehension (Aprianto *et al.*, 2020). The literature review on flipped learning indicates that this model enables a paradigm shift in teaching, where students study materials independently first and then use class time for discussions or practical applications (Upadhyaya, 2023). Research shows that flipped learning not only improves student comprehension but also provides more interactive and adaptive learning experiences, allowing for more student-centered teaching. Flipped learning helps students prepare materials in advance

through digital platforms, giving them the opportunity to learn at their own pace (Upadhyaya, 2023). This model allows teachers to focus more on classroom activities involving discussions and practical applications, significantly enhancing student interaction with materials and peers. Research also finds that flipped learning plays a major role in increasing student motivation, as they feel more responsible for their own learning process and more engaged in class. The relationship between the description and explanation of flipped learning data and the real-world problems faced shows that this teaching model can address issues related to low student engagement in traditional teaching. By allowing students to learn independently before class, flipped learning supports more flexible and student-centered learning. This model helps students better understand materials and then apply them in discussions and classroom activities, aligning with this study's goal of improving classroom learning quality (Sadeghi *et al.*, 2020). The learning classroom, according to the literature review, is an environment where various interactions between students and teachers occur. The reviewed studies frequently find that technology-based classrooms integrating multimedia tools and flipped learning can create more interactive environments that support student skill development (Nikitova *et al.*, 2020). This technology-based learning is not limited to materials delivered in class but extends beyond, creating broader and more flexible learning spaces.

This study finds that classrooms implementing technology-based teaching, such as multimedia-supported flipped learning, are more conducive to real-world teaching experiences. This aligns with findings showing that technology-integrated classrooms provide more opportunities for students to collaborate and interact with materials and peers (Sadeghi *et al.*, 2020). Classrooms facilitating active and interactive learning with multimedia tools can enhance student engagement and comprehension, making learning more effective. The description and explanation of learning classrooms are directly related to the problem addressed in this study: how to facilitate more interactive and adaptive learning. Technology- and multimedia-integrated classrooms can create more comprehensive learning experiences focused on student needs. Thus, this teaching model

offers solutions to challenges faced in traditional education, which often fails to accommodate active student engagement in learning (Aprianto *et al.*, 2020). The analysis of 20 reviewed articles reveals five dominant themes: (1) enhanced material comprehension, (2) improved student engagement, (3) learning flexibility and adaptability, (4) implementation challenges, and (5) support for learner autonomy. All 20 studies (100%) reported that multimedia use in flipped learning significantly improves students' understanding through visual and interactive content. Regarding engagement, 18 studies (90%) highlighted increased student participation, both cognitively and affectively. A majority (80%) also emphasized that multimedia-facilitated flipped learning supports flexible learning, allowing students to access materials independently and at their own pace. However, 12 studies (60%) identified limitations such as insufficient infrastructure, lack of teacher training in multimedia design, and inadequate digital literacy. A major gap is the limited number of studies that compare the effectiveness of different multimedia types (e.g., videos versus interactive simulations) quantitatively, or examine the influence of institutional context and learner characteristics on flipped learning outcomes. Furthermore, few studies measured long-term learning effects, highlighting a need for longitudinal investigations. Trend analysis indicates a surge in publications post-2020, driven by the widespread shift to online learning during the COVID-19 pandemic.

Recent studies (2022–2024) tend to be more exploratory, focusing on intensive multimedia integration and emphasizing emotional engagement. Some of these studies adopt mixed-method approaches, combining quantitative and qualitative data to offer a more holistic understanding, marking a positive evolution in research methodologies. In synthesis, although most articles conclude that multimedia positively supports flipped learning, there is considerable variation in instructional design approaches, technological platforms used, and evaluation strategies. These discrepancies highlight the importance of context-aware instructional design tailored to learners' needs. The findings also underscore that the effectiveness of flipped learning is closely tied to the readiness of the educational ecosystem both technologically and pedagogically. To

strengthen this thematic analysis, Table 4 below summarizes key findings from the 20 analyzed studies, along with their relevance to research objectives and the number of supporting studies for each finding. This presentation aims to provide a

quantitative overview of each finding's contribution to a comprehensive understanding of the impact of multimedia tools in flipped learning.

Table 4. Research Findings and Number of Supporting Studies

Research Finding	Relevance to Research Objectives	Number of Supporting Studies	Authors
Multimedia tools improve student comprehension in flipped learning.	Enhances student understanding in flipped learning.	20	Halili <i>et al.</i> (2021); Karsen <i>et al.</i> (2021); Nikitova <i>et al.</i> (2020); Upadhyaya (2023); Parker (2021); Nugraheni <i>et al.</i> (2020); Zhong (2020); Umar & Ko (2021); Teichgräber <i>et al.</i> (2023); Yilmaz <i>et al.</i> (2022); Ng (2022); Alodail (2020); Jung <i>et al.</i> (2022); Zain & Sailin (2020); Lee <i>et al.</i> (2020); Lo & Hew (2021); Fortepiani (2021); Kilavuz (2021); Ankora (2020); Nikitova <i>et al.</i> (2020)
Flipped learning with multimedia tools enhances student engagement.	Increases student engagement in flipped learning.	20	Lee <i>et al.</i> (2020); Zain & Sailin (2020); Zhong (2020); Ng (2022); Jung <i>et al.</i> (2022); Upadhyaya (2023); Karsen <i>et al.</i> (2021); Parker (2021); Nugraheni <i>et al.</i> (2020); Halili <i>et al.</i> (2021); Umar & Ko (2021); Lo & Hew (2021); Fortepiani (2021); Alodail (2020); Nikitova <i>et al.</i> (2020); Ng & Lo (2022); Yilmaz <i>et al.</i> (2022); Teichgräber <i>et al.</i> (2023); Kilavuz (2021); Ankora (2020)
Learning becomes more interactive and adaptive with multimedia.	Creates adaptive and interactive learning experiences.	18	Halili <i>et al.</i> (2021); Karsen <i>et al.</i> (2021); Nikitova <i>et al.</i> (2020); Upadhyaya (2023); Parker (2021); Nugraheni <i>et al.</i> (2020); Zhong (2020); Umar & Ko (2021); Teichgräber <i>et al.</i> (2023); Ng (2022); Alodail (2020); Jung <i>et al.</i> (2022); Zain & Sailin (2020); Lee <i>et al.</i> (2020); Lo & Hew (2021); Fortepiani (2021); Kilavuz (2021); Ng & Lo (2022)
Main implementation challenges include infrastructure readiness and digital skills.	Identifies implementation challenges.	12	Aprianto <i>et al.</i> (2020); Sadeghi <i>et al.</i> (2020); Ng (2022); Sharda & Bajpai (2021); Halili <i>et al.</i> (2021); Karsen <i>et al.</i> (2021); Jung <i>et al.</i> (2022); Nikitova <i>et al.</i> (2020); Kilavuz (2021); Yilmaz <i>et al.</i> (2022); Parker (2021); Ng & Lo (2022)
Flipped learning with multimedia supports	Enhances learning flexibility and	16	Umar & Ko (2021); Lo & Hew (2021); Ng & Lo (2022); Nikitova <i>et al.</i>

more flexible and responsive learning.	responsiveness through multimedia.		(2020); Jung <i>et al.</i> (2022); Zain & Sailin (2020); Parker (2021); Nugraheni <i>et al.</i> (2020); Zhong (2020); Lee <i>et al.</i> (2020); Halili <i>et al.</i> (2021); Karsen <i>et al.</i> (2021); Ng (2022); Upadhyaya (2023); Fortepiani (2021); Kilavuz (2021)
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Table 4 above summarizes key findings from the systematic literature review, reflecting five dominant themes in the use of multimedia tools in the flipped learning model. The first finding shows that 20 studies support the statement that multimedia tools significantly improve student comprehension of learning materials. This aligns with the basic principles of flipped learning, which encourage students to access learning materials independently before class activities begin. Additionally, student engagement is another important indicator supported by 20 other studies, indicating that multimedia use in flipped learning fosters active participation and emotional engagement during the learning process. Eighteen studies also emphasize that multimedia-based flipped learning creates more interactive and adaptive learning experiences, giving students room to explore according to their individual learning styles. On the other hand, implementation challenges such as infrastructure limitations and low teacher digital competencies remain barriers noted in 12 studies. The flexibility offered by this model is also supported by 16 studies, affirming that flipped learning allows students to learn in more flexible times and places. Thus, these findings not only support the research objectives of assessing the effectiveness of multimedia-based flipped learning but also provide a strong empirical basis for developing more responsive digital learning strategies tailored to student needs. The distribution of key findings from the 20 analyzed studies can be seen in Figure 2 below.

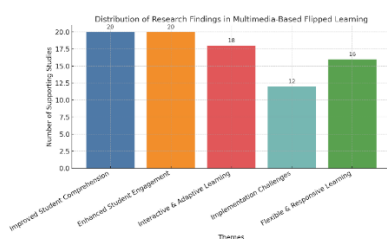


Figure 2. Distribution of Research Findings in Multimedia-Based Flipped Learning

The distribution graph in Figure 2 shows that most studies emphasize increased student engagement as the most dominant impact of multimedia implementation in flipped learning. This trend indicates that the success of the flipped learning model heavily depends on how well multimedia tools can create engaging and relevant learning experiences for students. The data visualization also underscores that material comprehension, learning time flexibility, and emotional engagement are important aspects that show improvement. Thus, multimedia-based flipped learning not only encourages active participation but also accommodates individual student learning needs more optimally, creating a more personalized and directed learning environment.

Discussion

The results of this study indicate that the use of multimedia tools in flipped learning-based teaching has a positive impact on student engagement in the teaching and learning process. Multimedia tools provide students with opportunities to learn independently through digitally available materials, followed by discussions and interactive activities in class. Flipped learning, supported by multimedia tools, has been proven to enhance student engagement, help them develop critical skills, and improve their understanding of the materials studied (Sadeghi *et al.*, 2020; Fasli, 2021). This study is closely related to several previous studies that also demonstrate the benefits of flipped learning in increasing student engagement. For example, research by Upadhyaya (2023) reveals that flipped learning can enhance learning motivation and student comprehension through the use of interactive technologies such as videos and applications. The strength of this study lies in its deeper focus on the specific impact of multimedia tools in flipped learning, contributing new insights to existing literature by showing that multimedia use supports more adaptive and personalized learning.

The results of this study show that flipped learning supported by multimedia tools can create more interactive and in-depth learning experiences. This reflects the importance of innovation in teaching methods that focus not only on material delivery but also on increasing student engagement. By reversing traditional teaching roles, flipped learning allows students to become more active in their learning process, aligning with this study's goal of improving teaching quality through technology. The implications of these findings are that the use of multimedia tools in flipped learning could be a highly effective strategy for improving education quality, especially in teaching contexts that demand active student engagement. This study demonstrates that by supporting technology-based learning, teachers can enhance student comprehension and engagement, which in turn can improve their learning outcomes. Therefore, implementing flipped learning in various educational settings can be a highly useful alternative for increasing teaching and learning effectiveness. The results of this study reflect the positive effects of multimedia tools in supporting flipped learning because multimedia provides flexible materials accessible anytime by students. This supports the self-directed learning that is a hallmark of flipped learning, where students can learn at their own pace, prepare materials before class, and use them for interactive activities in class (Sadeghi *et al.*, 2020). The success of flipped learning is also linked to students' direct involvement in discussion processes and practical applications, which enhances their comprehension. Based on these findings, the next steps include integrating more multimedia tools into flipped learning curriculum designs. Teachers need training in designing and utilizing multimedia effectively to support student self-directed learning. Additionally, providing adequate technological resources is crucial to ensuring equitable access for all students. Thus, flipped learning can be widely and effectively implemented, offering more engaging and adaptive learning experiences for students.

4. Conclusion

One of the most striking findings in this study is the fact that the use of multimedia tools in flipped learning not only improves student comprehension

but also significantly changes how students engage in the learning process. Multimedia tools included in the flipped learning model not only provide easier access to learning materials but also accelerate students' mastery of practical and analytical skills in a much shorter time compared to traditional teaching methods. Students not only become more active in learning but also show improvements in collaboration and critical skills, which have been difficult to achieve in conventional teaching. This study makes highly important contributions both theoretically and practically. Theoretically, it adds insights into how multimedia tools can enhance the effectiveness of flipped learning in technology-based teaching contexts. These findings reinforce Vygotsky's social constructivism theory, which emphasizes the importance of social interaction and tool use to facilitate deeper understanding (Vygotsky, 1978). Practically, this study paves the way for developing more adaptive and student-needs-responsive technology-based curricula, demonstrating that multimedia-supported flipped learning has the potential to improve overall education quality. Although this study yields interesting findings, there are several limitations to note. One is the limited sample size, involving only certain educational settings. Future research could expand by including more variables such as the types of multimedia tools used, learning duration, and the types of materials studied. Further studies could also explore how external factors like technology access and student digital skills influence the effectiveness of flipped learning. Thus, subsequent research could provide a more holistic picture of flipped learning implementation across various educational settings and disciplines.

5. References

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