Article

The Utilization of 3D Animation as a Learning Medium for the Effectiveness of Students' Learning

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A B S T R A C T

The utilization of 3D animation has emerged as an innovative and promising technology to enhance learning experiences by presenting complex information in an engaging visual format. This study aims to explore the utilization of 3D animation as a learning medium and its impact on students' learning effectiveness. Using the Systematic Literature Review (SLR) method and the PRISMA approach, this research reviews literature from 2019 to 2024. The findings indicate that 3D animation can enhance students' motivation, interest, and learning outcomes. It helps students understand abstract concepts through realistic and interactive visualizations, making learning more engaging and effective. Additionally, this animation allows students to actively participate in the learning process. However, challenges such as hardware limitations and lack of teacher training hinder effective implementation. Therefore, collaboration among technology developers, educators, and policymakers is essential to overcome these barriers and maximize the potential of 3D animation in education. By optimizing the potential of 3D animation, this technology can revolutionize traditional teaching methods by creating more interactive, enjoyable, and relevant learning experiences in the digital era.

Keywords: *3D Animation, Learning Effectiveness, Interactive Visualization*

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INTRODUCTION

Education stands as a cornerstone of national development, directly influencing the quality of life and shaping the foundation for a progressive society. By equipping individuals with knowledge, skills, and values, education contributes to the creation of responsible citizens who are capable of participating actively in various aspects of social, economic, and cultural life (UNESCO, 2020). It prepares future generations to face global challenges and provides them with the intellectual tools necessary for innovation and change (OECD, 2021).

Teachers, as key agents in the educational system, are instrumental in achieving these national goals. They are not only knowledge transmitters but also facilitators of meaningful learning experiences. Their ability to select appropriate teaching methods and relevant learning media significantly determines the success of the learning process (Darling-Hammond et al., 2020). In this capacity, teachers must adapt to the evolving demands of education, especially in response to the rapid pace of technological advancement in the digital age (Ertmer & Ottenbreit-Leftwich, 2020).

The advent of the digital era has brought about a transformative shift in the education sector. Traditional classroom practices have been increasingly supplemented—or in some cases, replaced—by digital learning environments. The global COVID-19 pandemic further accelerated this transformation, necessitating the swift adoption of online learning platforms (Bozkurt et al., 2020). As a result, the integration of digital technologies into teaching and learning has become not only relevant but essential (Dhawan, 2020).

Among the many technological innovations in education, the use of digital animation—particularly 3D animation—has gained considerable attention. 3D animation is not only visually engaging but also interactive, making it a powerful tool for enhancing students' understanding, especially of abstract or complex concepts (Mayer, 2021). Unlike static images or printed texts, 3D visuals can simulate real-life scenarios and provide dynamic learning experiences that stimulate higher-order thinking (Lai et al., 2021).

Over time, there has been a noticeable shift in students' learning preferences. Interest in traditional printed learning materials has been steadily declining, while digital formats that offer interactive and immersive experiences are increasingly favored (Zhu et al., 2020). This trend highlights the need for educational institutions and teachers to rethink their instructional approaches and incorporate more innovative media to meet the evolving expectations and learning styles of today's students (Bower et al., 2020).

This study seeks to explore the role of 3D animation as a digital learning medium and assess its impact on student learning effectiveness. Using the Systematic Literature Review (SLR) method, the research analyzes relevant studies published between 2019 and 2024 (Kitchenham & Charters, 2007). This approach ensures a comprehensive and evidence-based understanding of how 3D animation contributes to the learning process across different educational contexts (Siddaway et al., 2019).

In addition to evaluating its effectiveness, this study also examines the opportunities and challenges associated with the integration of 3D animation into the classroom. While the benefits are promising, implementation is not without hurdles. These include limited technological infrastructure, insufficient training for teachers, and the need for well-developed, curriculum-aligned digital content (Fitria & Hafizh, 2021; Qureshi et al., 2021). Addressing these barriers is crucial for maximizing the educational value of 3D animation.

The findings of this research are expected to inform educators, content developers, and policymakers about the strategic use of 3D animation in education. By identifying both the advantages and constraints of this technology, the study aims to support the creation of more engaging, inclusive, and effective teaching strategies that align with 21st-century learning demands (Voogt & Roblin, 2020). In doing so, it contributes to the ongoing efforts to harness digital innovation for educational advancement (Redecker, 2019).

METHOD

This study is a documentation study using the Systematic Literature Review (SLR) method with a PRISMA approach to systematically review the utilization of 3D animation as a learning medium. The steps taken include formulating the background to understand the impact of 3D animation on learning effectiveness, developing research questions (RQs) such as the effect of 3D animation on learning effectiveness compared to conventional media, and identifying influencing factors. Literature searches were conducted using the keywords "3D Animation" and "Learning Effectiveness" through platforms such as Google Scholar, Scopus, and Publish or Perish.

The selection criteria stage includes determining inclusion (articles from 2019–2024, accredited national and international journals) and exclusion (topic relevance, methodological quality, accessibility, and duplication). Quality evaluation was conducted using Quality Assurance (QA) based on publication year range, use of 3D animation, and journal accreditation. Data from the selected articles were then extracted to answer the research questions and synthesized using a narrative method, classifying findings to comprehensively address the research objectives.

The subject of this study is relevant scientific literature, while the object is the use of 3D animation in learning and its effectiveness. The data analysis technique used is meta-synthesis, which analyses and integrates data from various studies to provide a more in-depth and comprehensive understanding. The results of this study are expected to systematically answer research questions and contribute to the development of 3D animation-based learning media.

This study follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram, illustrating the article screening process through three main stages: Identification, Screening, and Inclusion.
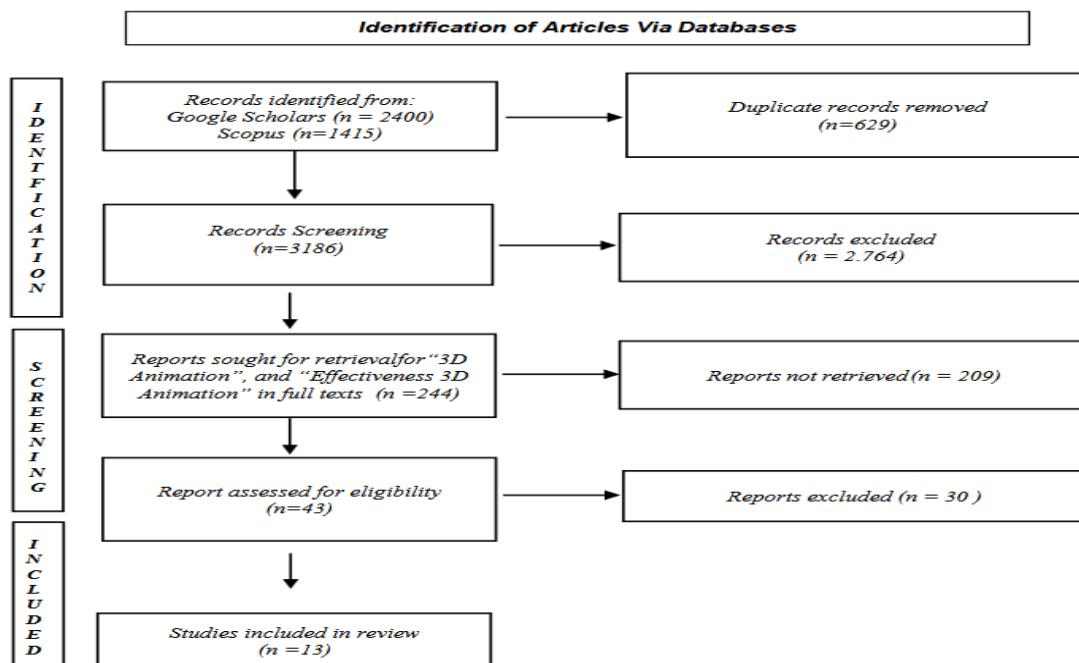

Figure 1. PRISMA Diagram: Systematic Literature Review Stages

FINDINGS AND DISCUSSION

The search results using various keywords such as "Efektivitas Animasi 3D," "Effectiveness of 3D Animation," "Animasi 3D," and "3D Animation" showed a varying number of articles across two databases, Scopus and Google Scholar, as presented in Table 1. The utilization of 3D animation media as a learning tool can influence students' interest and motivation in learning. Additionally, 3D animation is considered to have potential for use in educational activities; however, there are also challenges that need to be addressed. This aligns with previous studies, which are presented in Table 2.

Tabel 1. Article Database

No	Keywords	Scopus	Google Scholar
1	Effectiveness of 3D Animation	0	600
2	Effectiveness 3D Animation	214	600
3	3D Animation	1	600
4	3D Animation	1200	600
Total Articles	**1415**	**2400**	

Table 2. Research Findings Related to the Effectiveness of 3D Animation

No	Reference	Title	Research Method & Sample	Data Collection Method	Research Finings
1	Teplá, M., Teplý, P., & Smejkal, P. (2022)	Influence of 3D models and animations on students in natural subjects	Quantitative Experimental Method with a total sample of 565 students from secondary	Motivated Strategies for Learning Questionnaire, Intrinsic Motivation	The use of 3D models and animations increases students' intrinsic motivation and learning

			and high schools in the Czech Republic	Inventory, and knowledge test	outcomes in science, particularly in chemistry and biology. The positive effect is stronger in students aged 11–13.
2	Kumar, A., Saudagar, A.K., Alkhathami, M., Alsamani, B., Khan, M.B., Hasanat, M.H., Ahmed, Z.H., Kumar, A., & Srinivasan, B. (2023)	Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation	Mixed methods; Total sample: 612 students	Questionnaire-based survey; VR simulation testing	VR positively affects motivation, confidence, and learning outcomes in medical and biology education.
3	Ferry, D., & Kamil, D. (2019)	Improving Students' Biology Learning Outcomes Through the Application of 3D Animation Video Media	Classroom Action Research (CAR), 18 students	Observation, Tests (Pretest and Posttest)	3D animation video media improves students' learning outcomes. The average score increased from 74.94 (cycle I) to 81.27 (cycle II).
4	Sari, D. A. M., Murtono, & Fathurohman, I. (2021)	Development of 3D Animation Video Media in Traditional Petak Benteng Games for Motor Skills	R&D; Experimental sample = 39 students, Control = 37 students	Observation, Documentation, Questionnaire, Interview	3D animation video media effectively improves students' motor skills and can be used as an online learning medium.
5	Lyanda, D., Halim, R. N., & Syakti, F. (2023)	3D Animation Learning Media of the Solar System Using the ADDIE Method	This study used the ADDIE method with a sample of 30 students from SMA Negeri 08 OKU	Observation and questionnaire	70% of students agree that 3D animation provides a better understanding of the solar system, increases learning interest, and helps comprehend planetary scales.

6	Amelia, C.R., Usman, H., & Wardhani, P.A. (2024)	Needs Analysis for the Development of 3D Animation Video Media Based on Blender in Civics Subject for 5th Grade	Research and Development (R&D); Sample: 30 fifth-grade students and 1 teacher from SDN Lenteng Agung 01	Interview, student and teacher questionnaires	3D media based on Blender is highly needed, helps increase students' motivation and understanding in Civics subject.
7	Rahmawati, S., & Usamah, A. (2024)	The Effect of 3D Animation in Assemblr Edu on 5th Grade Students' Learning Interest in the Water Cycle Material at SDN 1 Pakemitan	Quantitative method, Quasi-Experimental design (Pretest-Posttest Control Group), sample: 38 fifth-grade students (19 experimental, 19 control)	Tests, Likert scale questionnaire, observation, documentation	3D animation in Assemblr Edu significantly increases students' learning interest. The posttest average score in the experimental class (93.16) was higher than in the control class (72.63). Learning interest increased by 24% in the experimental class, compared to only 10% in the control.
8	Firmansyah, A. F., Azizah, W. A., Widodo, S. T., & Isdhianti, E. (2023)	The Effect of Applying the PBL Model Assisted by 3D Animation Media on Pancasila Education Learning Outcomes in 5th Grade	Quantitative method, pre-experimental (One Group Pretest-Posttest Design), sample: 28 fifth-grade students from SD Negeri Tambangan 02	Tests, observation, interview	The use of the PBL model with 3D animation media significantly improves students' learning outcomes (sig. 0.000). The average pretest score of 57.21 increased to 67.79 in the posttest.
9	Hia, E. K. K., Harahap, A. S., & Nugraha, A. W. (2022)	The Effect of 3D-Based Learning Media and Molecular Animation with SAVI Cooperative	Quantitative Experimental Method, 2 classes (experimental and control), total of 72 students	Tests (pre-test and post-test), questionnaire	3D-based learning media and molecular animation improve chemistry learning outcomes. The

		Type on Chemistry Learning Outcomes in 10th Grade on Electrolyte and Non-Electrolyte Solutions			average score in the experimental class (78.75) was higher than in the control class (71.66). Student response was very positive (92.42%).
10	Rahmawati, A. D., Yani, M. T., & Setyowati, R. R. N. (2023)	Development of 3D Animation "KESUBA" to Improve Learning Outcomes and Students' Character Values in 4th Grade at MI Bahrul Ulum Surabaya	Quantitative Pre-experimental Method, 25 students	Tests, observation, interview, questionnaire	3D animation media improves learning outcomes, obtaining an average score of 80%, which falls into the "Highly Feasible" category for learning.
11	Putri, A. (2024)	Effectiveness of Digital Learning Media Using 3D Animation to Improve Elementary School Science Learning Outcomes: Literature Review	Literature Review, 6 articles	Literature Analysis	Digital learning media based on 3D animation has been proven effective in improving elementary school science learning outcomes.
12	Budiman, D. (2023)	Development of 3D Animation Visual Media for Learning Milling Machine Operations	Descriptive quantitative method, sample: 10th-grade students from SMAN 1 Cigugur	Journal-based literature review and quantification of 3D-based learning media effectiveness	3D-based learning media improves the effectiveness of geography learning on the atmosphere topic, making it more engaging and interactive than conventional methods.
13	Sari, P., Okra, R., Musril, H.A. (2023)	Design of 3D Animation Learning	Research and Development (R&D) with	Validity, practicality, and	The media is valid (0.87), practical (0.92),

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Media for Physical Education and Health Subjects at MTsN 6 Agam	the DDD-E model; Sample: 15 ninth-grade students and 2 PE teachers at MTsN 6 Agam	effectiveness questionnaires	and effective (0.84); increases student interest in swimming lessons.	

Table 3. Quality Assessment Results

No	Title	QA1	QA2	QA3	QA4	Result
1	Influence of 3D models and animations on students in natural subjects	Y	Y	Y	Y	✓
2	Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation	Y	Y	Y	Y	✓
3	Peningkatan Hasil Belajar Biologi Siswa Melalui Penerapan Media Video Animasi Tiga Dimensi (3D)	Y	Y	Y	Y	✓
4	Pengembangan Media Video Animasi 3D Dalam Permainan Tradisional Petak Benteng Untuk Keterampilan Motorik	Y	Y	Y	Y	✓
5	Media Pembelajaran Animasi 3D Sistem Tata Surya Menggunakan Metode ADDIE	Y	Y	Y	Y	✓
6	Analisis kebutuhan pengembangan media video animasi 3D berbasis Blender pada mata pelajaran PPKn di kelas V	Y	Y	Y	Y	✓
7	Pengaruh animasi 3D dalam Assemblr Edu terhadap minat belajar siswa kelas V materi siklus air di SDN 1 Pakemitan	Y	Y	Y	Y	✓
8	Pengaruh Penerapan Model PBL Berbantuan Media Animasi 3D Terhadap Hasil Belajar Pendidikan Pancasila Kelas V	Y	Y	Y	Y	✓
9	Pengaruh media pembelajaran berbasis 3D dan animasi molekul dengan kooperatif tipe SAVI terhadap hasil belajar kimia siswa SMA kelas X pada materi larutan elektrolit dan non-elektrolit	Y	Y	Y	Y	✓
10	Pengembangan Animasi 3D "KESUBA" untuk Meningkatkan Hasil Belajar dan Nilai Karakter Peserta Didik Kelas IV MI Bahrul Ulum Surabaya	Y	Y	Y	Y	✓
11	Effectiveness of Digital Learning Media Using 3D Animation to Improve Elementary School Science Learning Outcomes: Literature Review	Y	Y	Y	Y	✓
12	Pengembangan media visual animasi 3D untuk pembelajaran operasional mesin frais	Y	Y	Y	Y	✓
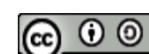
| 13 | Perancangan Media Pembelajaran Animasi 3D Pada Mata Pelajaran Pendidikan Jasmani Olahraga Dan Kesehatan Di MTsN 6 Agam | Y | Y | Y | Y | ✓ |

Explanation:
QA1: Journal publication year 2019-2024
QA2: Uses 3D Animation Learning Media
QA3: Subjects: Elementary to Higher Education Students
QA4: Accredited in a National or International Journal

The use of 3D animation-based learning media has proven effective in enhancing students' motivation, learning interest, and academic outcomes across various fields, such as science, biology, chemistry, and civics education. Research shows that this technology provides a better understanding, increases self-confidence, and supports online learning as well as the development of motor skills. Moreover, 3D animation is capable of making abstract concepts more concrete, thereby facilitating material comprehension and improving students' memory retention.

Despite its many benefits, the implementation of 3D animation in education still faces challenges, such as limitations in technological devices, insufficient training for educators, and the need for the development of relevant and high-quality content. Therefore, collaboration among technology developers, educators, and policymakers is necessary to ensure more effective and equitable implementation across all levels of education.

CONCLUSIONS

Overall, the studies above demonstrate that 3D animation-based learning media have significant potential to enhance student learning effectiveness across various educational levels. Data obtained through the Systematic Literature Review (SLR) method indicate that 3D animation can significantly improve students' motivation, understanding, and learning outcomes. However, the implementation of this media still faces several challenges, such as device limitations, lack of teacher training, and accessibility to technology. Therefore, collaboration between educators, technology developers, and policymakers is essential to create more inclusive and affordable solutions. By integrating 3D animation into the learning process, these research findings provide a strategic direction to support the transformation of education toward a more effective and equitable digital era.

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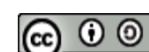
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