PAPANDA

Implementation of Interactive Multimedia to Improve Science Literacy of Elementary School Students: Systematic Literature Review

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Abstract
The low level of scientific literacy among elementary school students is a serious challenge in the world of education, especially in facing the demands of the 21st century which emphasizes critical thinking skills, problem solving, and understanding scientific concepts. One of the causes is the lack of interesting learning media that can accommodate students' learning needs as a whole. Therefore, innovation is needed in the form of interactive learning multimedia that can present material in an attractive visual way and actively involve students. This study aims to implement and examine the effectiveness of using interactive learning multimedia in improving elementary school students' scientific literacy. This study uses the Systematic Literature Review (SLR) method to analyze and synthesize various relevant studies on the implementation of interactive learning multimedia in the context of improving scientific literacy. Data were collected from various reputable national and international journals in the period 2017 to 2023, using databases such as Google Scholar, DOAJ, and GARUDA. The selection process was carried out with strict inclusion and exclusion criteria to obtain relevant and quality articles. A total of 10 articles were selected for analysis. The results of the study showed that most studies concluded that interactive multimedia has a positive influence on improving students' scientific literacy skills. This media has been proven to improve conceptual understanding, critical thinking skills, and increase students' interest and motivation to learn. In addition, the use of visual elements, animation, and simulation in multimedia can bridge students' difficulties in understanding abstract concepts in science. Thus, it can be concluded that interactive learning multimedia tends to be effective and relevant in improving elementary school students' scientific literacy. However, limitations such as small sample sizes or context-specific findings in some studies should be considered. These findings provide implications for teachers, media developers, and policy makers to integrate multimedia technology more optimally in science learning.

INTRODUCTION

Professional teachers are required to be able to investigate various strategies that can attract students' attention so that the learning process runs effectively. However, it is important to realize that each basic skill taught to students has a different level of difficulty, while students' abilities and learning styles also vary (Rahim & Fadhilah, 2023). Therefore, teachers must be able to adjust the learning media used to reach all student learning needs optimally. The use of appropriate learning media is an important factor in the success of the learning process in the classroom. Interesting and innovative learning media can help teachers convey material more clearly and pleasantly, so that it can increase students' motivation to learn (Fadilah et al., 2023).

Learning media is a vital foundation in the educational process because it functions as a communication tool that connects messages from teachers to students effectively. Harahap et al. (2022) explaining that media is everything that can be used to channel messages from sender to receiver, so that it can stimulate students' thoughts, feelings, interests, and attention so that an optimal learning process occurs. Along with the development of technology and the times, learning

media must continue to be developed to remain relevant and able to meet the learning needs of today's students. One of the fastest-growing learning media innovations is interactive multimedia that combines various elements such as text, graphics, sound, video, and animation that can clarify and enrich the delivery of learning materials (Wibowo, 2023).

Interactive multimedia allows students to learn actively and independently by presenting material that is not only informative, but also engaging and interactive. According to Safitri & Aziz (2022), Interactive multimedia combines various components such as text, graphics, audio, and animation combined in a system that can be used on a computer or laptop device to illustrate learning concepts in a more vivid and engaging way. This allows students to learn according to their abilities and pace (Nurhayati & Langlang Handayani, 2020). Thus, interactive multimedia can be an effective solution in overcoming students' difficulties in understanding abstract and complex material (Kustandi & Darmawan, 2020). The use of learning media, especially interactive multimedia, can trigger students' desire and interest in learning so that the learning process becomes more fun and meaningful. Sumarsono (2024) emphasizing that learning media plays an important role in providing positive psychological motivation and stimulation for students during the teaching and learning process. This is in line with the opinion Munir et al. (2023)which states that learning media functions as a tool to clarify the meaning of the message conveyed, so as to enable the achievement of learning objectives more effectively and on target.

The learning process itself is defined as a relatively permanent change in an individual's abilities as a result of practice and learning experience (Rahmansyah, 2021). According to Liriwati (2023) learning is a change in a person's disposition or capacity that lasts over a period of time and is not simply the result of a natural growth process. In the context of learning in elementary schools, these changes include the improvement of students' cognitive, affective, and psychomotor abilities obtained through a structured learning process supported by the right media (Solihin et al., 2024). Therefore, interactive learning media is expected to be able to facilitate these positive changes optimally. Assessment and evaluation are an integral part of the learning process that aims to measure the extent to which learning objectives have been achieved. According to Mujiburrahman et al. (2023), Assessment is a systematic and continuous process to collect information about students' learning processes and outcomes in order to make decisions based on certain criteria. Evaluation is also carried out to determine the level of success of students in understanding the learning material that has been delivered. Evaluations carried out in a transparent and systematic manner can provide an accurate picture of the effectiveness of the learning media used and the level of literacy of students in various fields of knowledge.

Science literacy is one of the aspects of digital literacy that is very important for every individual to have in the modern era. Reffiane et al. (2025)emphasizing that science literacy includes knowledge and understanding of scientific concepts and processes necessary for decision-making, social participation, and cultural and economic development. In the life of a society that is increasingly dependent on technology and science, science literacy plays an important role in dealing with various contemporary issues related to science and technology (Werdiningsih, 2021). Thus, science literacy is an important skill that must be developed from an early age, especially at the elementary school level. Science literacy not only refers to the ability to understand science concepts, but also involves the ability to engage in science-related problems critically and reflectively (Parisu et al., 2025). Science literacy is one of the competencies of the 21st century that is the main focus in the modern education curriculum. Therefore, science learning in elementary schools needs to be supported by learning media that are able to improve students' science literacy skills effectively and fun. According to the 2018 PISA results, Indonesian students scored below the OECD average in scientific literacy, ranking 70th out of 78 participating countries (OECD, 2019). This data highlights the urgency of improving science literacy at the basic education level. The implementation of interactive multimedia in science learning is expected to answer these challenges.

Based on this presentation, this research was conducted using the Systematic Literature Review (SLR) approach to identify, analyze, and synthesize research findings related to the implementation of interactive multimedia in improving the science literacy of elementary school students. The SLR approach allows researchers to comprehensively review relevant previous research results, so as to provide a clear picture of the trends, advantages, and disadvantages of the use of interactive multimedia in the context of science learning. However, few systematic reviews have focused specifically on the intersection between interactive multimedia and science literacy in elementary education, especially in the Indonesian context. This gap is what the present study aims to address.

This research is important to provide a scientific foundation in the development of innovative and effective learning media. The main objective of this study was to evaluate the extent to which interactive multimedia has been used and effective in improving science literacy in elementary school students. In addition, the results of this study are expected to provide recommendations for teachers, media developers, and education policymakers to optimize the use of multimedia technology in the science learning process. Thus, this research can contribute to improving the quality of learning and achieving better science literacy at the basic education level.

METHODS

This study is a qualitative descriptive research using the Systematic Literature Review (SLR) approach. The literature used is literature that is relevant to the problems and objectives of the research by identifying, reviewing, evaluating and interpreting all available research. With this method, the researcher identifies journals and conducts a systematic review and follows the steps that have been set (Putra & Milenia, 2021). This study uses a systematic review stage model that separates the two stages into four separate stages, namely the first stage of literature search and the process of extracting information from the research. The second stage includes the process of summarizing and integrating evidence from individual studies and interpreting the cumulative findings that emerge which is packaged in 7 stages (Hadi & Palupi, 2020).

The inclusion criteria used in this study were: (1) research articles published between 2017–2023; (2) studies focused on the implementation of interactive multimedia in science learning at the elementary school level; (3) studies that reported outcomes related to science literacy; (4) peer-reviewed journal articles; and (5) full-text availability in Indonesian or English. The exclusion criteria included: (1) articles that were not based on empirical research (e.g., opinion pieces or conceptual papers); (2) studies focusing on secondary or tertiary education levels; and (3) duplicate publications. The reduction from 30 to 10 articles was based on the application of these inclusion and exclusion criteria, as well as the quality of the study methodology and relevance to the research questions.

Table 1. Stages of Systematic Review

Stages	Research questions	Purpose	Variations of the procedure
Formulate problem	Is there relevance to the research question?	Define variables and their relationships to determine their relevance	Variations in conceptualization and definitions can cause differences in operationalization
Literature search	What procedure should be used to find relevant articles?	Identify sources (digital libraries) and keywords to search for articles	Variations in search sources can cause differences
Collecting information from articles	What information is relevant to the problem or research question?	Collect relevant information from articles reliably	Variations in (a) labeling important results and (b) focusing only on certain studies can cause differences in interpretation of findings
Evaluating research quality	What research procedures can be used in the synthesis?	Identify and apply criteria to select studies appropriate for the research question	Variations in criteria for deciding which studies to include in the synthesis can cause differences
Analyzing and integrating research results	What procedure should be used to summarize and	Identify and apply procedures to combine results across studies and test differences	Variations in procedures used, such as narrative, vote counting, average effect size, can cause

	combine research results?	among them	differences in cumulative results
Interpreting evidence	What conclusions can be written cumulatively from the research evidence?	Summarize cumulative research evidence regarding general findings first, then strengths and limitations of studies	Variations in (a) labeling important results and (b) focusing only on certain studies can cause differences in interpretation of findings
Presenting results	What information should be included in the systematic review report?	Identify and apply editorial guidelines to facilitate reader understanding	(a) Guide readers to assess the confidence level in synthesis results and (b) influence others to replicate the results

Literature searches were carried out through electronic databases such as Google Scholar, DOAJ, and Garuda with the keywords "interactive multimedia" and "science literacy". Data collection is done by documenting all articles obtained from relevant research. This research initially collected 30 articles relevant to multimedia, interactive learning and science literacy. The article was then reduced to 10 articles relevant to multimedia, interactive learning, and science literacy. According to Miles & Huberman (2013) there are 4 stages of analysis for qualitative research, namely: (1) data collection to obtain data from various reliable sources; (2) data reduction to make it easier to obtain the desired data; (3) Data presentation, namely the presentation of research data; (4) Conclusion and verification.

RESULTS AND DISCUSSION
Result

The first step that the researcher took in this study was to formulate problems related to *the Systematic Literature Review* (SLR) research on the implementation of interactive learning multimedia with the improvement of students' science literacy. The second research conducted by researchers is a literature search that researchers take from accredited sources such as *google schooler*, DOAJ (*Directory Open Access Journals*), and GARUDA (Digital Reference Guard). The following is a search image conducted by the author.
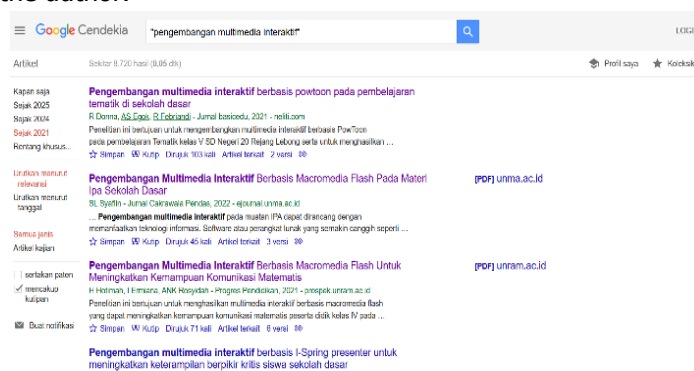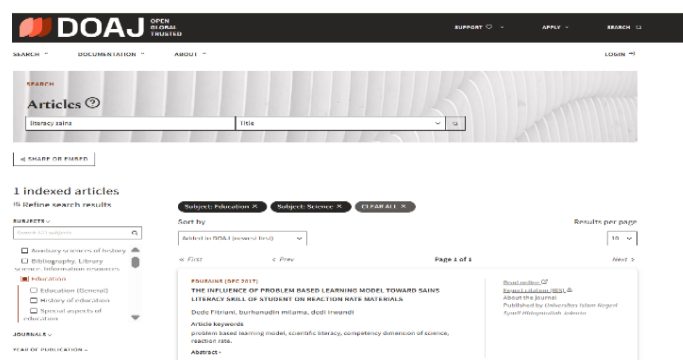

Figure 1. Search through *google schoolar*
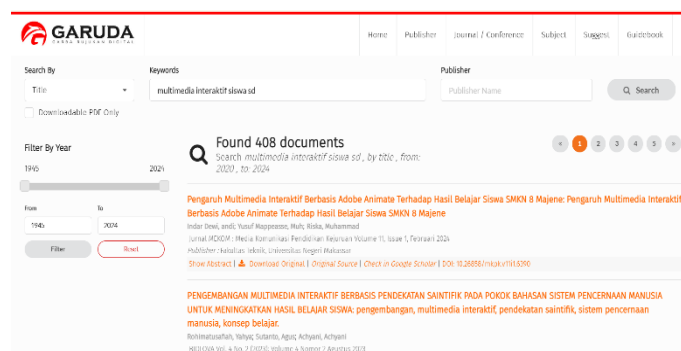

Figure 2. Search via DOAJ

Figure 3. Search via GARUDA

The next steps that the researcher takes in collecting information from the article, evaluating the quality of the research, analyzing and integrating the research results and interpreting the evidence are presented in the table below.

Table 2. Collection of information from relevant articles

Author	Findings	Recommendations
(Kifron, 2024)	Interactive learning multimedia was developed using Adobe Flash Professional CS6 along with supporting software such as Adobe Photoshop CS6, Microsoft Office, Corel Draw X7, Adobe Premiere Pro CS6, and Swivel. The development followed the ADDIE model and proved effective in improving science learning outcomes.	Teachers are encouraged to develop interactive learning multimedia to increase student engagement during learning, which positively impacts learning outcomes. This study proves that applying interactive multimedia significantly contributes to student achievement improvement.
(Anggraeni et al., 2021)	Video-based interactive learning multimedia successfully increased elementary students' learning interest. The product was developed using Adobe Flash CS5 and Kinemaster applications, presented as a 7-minute video on DVD. After use, there was an increase in students' interest and attention with N-gain values in the medium category (0.61 and 0.69).	It is recommended to use video-based interactive multimedia as a learning strategy to enhance student interest, as the study shows significant improvement in students' attention and interest after the media application.
(Wahyuningsih et al., 2022)	Technological developments positively impact education, especially in learning media creation. This study tested the validity and practicality of Adobe Flash-based Interactive Media with a Content and Language Integrated Learning (CLIL) approach for 4th-grade students on folk tales. The R&D method using Sugiyono's procedure showed validity and practicality through media experts, material validators, teachers, and students as valid and very practical. Pretest to posttest scores increased by 26%, significantly.	Macromedia Flash 8-based interactive media is recommended as a valid and practical learning medium for the theme "My Experience" in 2nd-grade elementary schools.
(Qistina et al., 2019)	Interactive multimedia in the form of a science learning CD for 4th-grade students developed using Adobe Flash is declared feasible and effective in the learning process.	This study can serve as a reference for teachers to develop learning using interactive multimedia to increase student activity during learning. Schools can also use this media as an information source to improve education quality.
(A. I. Putra, 2023)	Development of interactive learning media based on PowerPoint using the R&D model with the DDD-E (Decide, Design, Develop, Evaluate) stage is proven highly valid and feasible for mathematics learning.	PowerPoint-based interactive learning media is recommended for use in mathematics learning processes due to its thoroughly tested validity and feasibility.
(Riyadi & Wibawa, 2024)	Increasing the effectiveness of PPKN (Civic Education) learning in 5th grade elementary students is necessary. This article develops	Teachers and media developers need to ensure the selection of appropriate learning media according to objectives and content.

	interactive learning media based on Quizizz as an alternative to improve PPKN learning quality. Qualitative analysis shows media suitability with learning objectives and its potential effectiveness in improving PPKN concept understanding.	Innovation in interactive learning media is essential to enhance appeal, effectiveness, and inclusivity in digital-era learning.
(Rahman & Nyoman, 2020)	Interactive multimedia learning in integrated social studies developed using the ADDIE model effectively improves student learning outcomes.	Interactive multimedia is recommended as an effective medium in integrated social studies learning to significantly improve student outcomes.
(Manurung, 2020)	Multimedia proven to increase student interest and motivation, especially during the Covid-19 pandemic, which caused a decline in learning interest. Multimedia also becomes a fun and innovative solution for online learning.	Multimedia is encouraged as an innovative and enjoyable solution for online learning to increase student interest, and as an alternative relevant to technological and scientific developments.
(Najib et al., 2023)	Learning multimedia is recommended as an effective tool to introduce and deepen students' understanding of the solar system based on science literacy at the elementary school level.	This learning multimedia is recommended as an effective instructional aid to enhance students' understanding of the solar system based on science literacy in elementary schools.
(Yulia & Putri, 2024)	The use of Assemblr Edu interactive media based on augmented reality effectively increased 6th-grade students' science literacy, with a score improvement of 38%.	Assemblr Edu-based augmented reality media is recommended for widespread implementation in science learning to significantly improve concept understanding and student interest.
(Sufiyanto & Hefni, 2023)	Artificial intelligence technology proves effective in attracting interest and improving science literacy in elementary students through digital learning media and applications.	Educators are advised to integrate artificial intelligence technology in science learning to create interactive, personalized learning experiences tailored to 21st-century student needs.
(Evalina et al., 2024)	The application of Problem Based Learning (PBL) model with innovative learning media effectively improves science literacy in elementary students, shown by significant increases in pretest and posttest scores.	Teachers are encouraged to integrate the PBL model and innovative learning media in science teaching to increase student engagement, critical thinking skills, and deep concept understanding.
(Filjinan et al., 2022)	The use of interactive e-comics in science learning is highly valid, practical, and effective in improving science literacy in junior high students, with an N-gain value of 0.60.	Interactive e-comics are recommended as an alternative science learning medium capable of enhancing student engagement, facilitating concept comprehension, and accessible flexibly via digital devices.
(Febryana et al., 2021)	Learning media based on eXe Learning significantly improves science literacy ability in 9th-grade MTs students, indicated by t-test results showing t-count > t-table and increased average scores in the experimental group compared to the control.	eXe Learning media is recommended to be integrated into science learning to support concept understanding, problem-solving, and active student participation through interactive features and virtual labs.
(Safira & Nahdi, 2024)	Interactive multimedia based on science literacy and character for 4th-grade elementary students is highly valid, practical, and effective in improving material comprehension and learning motivation.	It is recommended to widely use interactive multimedia based on science literacy and character in elementary schools to support science competency achievement along with integrated character formation.
(Pratama et al., 2023)	Animation video-based media significantly improves science literacy in 4th-grade students, shown by increased average post-test scores and t-count > t-table.	Animation video media is recommended for use in science learning to effectively improve concept understanding, motivation, and student interest.
(Purwaristi & Wahyudi, 2024)	Interactive comic media based on the TGT model effectively improves science literacy in 4th-grade elementary students with significant score increases.	Interactive comics are recommended as an alternative learning medium in science/social studies that can increase reading interest, student engagement, and science literacy in a fun and contextual way.
(Hidayat., 2024)	Development of science literacy media (Melisa) based on Construct 2 effectively improves	Development and integration of science literacy media (Melisa) in social studies

science literacy skills and learning outcomes of 5th-grade elementary students with high literacy ability categories.	learning in elementary schools is recommended, considering internet stability and teacher guidance to maximize sustainable media use.

Disscussion

This discussion examines various current research on the development and application of interactive learning media at the elementary school (SD) and junior high school (SMP) levels. Interactive learning media has been proven to be effective in improving student learning outcomes, especially in science and social studies subjects. Kifron (2024) developed interactive learning multimedia using Adobe Flash Professional CS6 and other supporting software, with the ADDIE model as the basis for its development. The results of the study showed a significant increase in students' science learning outcomes. This confirms that interactive multimedia is able to increase student activity and have a positive impact on the achievement of academic competence (Kifron, 2024). Similar research by Rahman and Nyoman (2020) on social studies subjects also shows that the use of interactive multimedia significantly improves learning outcomes. These two studies reinforce the importance of using interactive technology as part of effective learning strategies in elementary schools.

Apart from learning outcomes, the use of interactive multimedia also contributes to increasing students' interest and motivation to learn. Manurung (2020) revealed that multimedia became an innovative solution during the online learning period during the Covid-19 pandemic, where students' interest in learning decreased. The use of multimedia allows learning to be more fun and interesting for students, so that it is able to maintain learning motivation in distance learning conditions. Anggraeni et al. (2021) also found that video-based multimedia can increase students' interest in learning by increasing N-gain scores in the medium category. These findings strengthen the argument that interactive multimedia-based learning media not only serves as a tool for delivering material, but also as a driver of students' intrinsic motivation in learning.

The validity and practicality of interactive learning media are important aspects that need to be considered in the development process. Wahyuningsih et al. (2022) examined the validity and practicality of Adobe Flash-based interactive media with the Content and Language Integrated Learning (CLIL) approach. The results of the study showed that the media was very valid and practical to use, with an average score of 87% of media validators and a very positive response from teachers and students. This indicates that interactive media developed with systematic research and development procedures can meet high quality standards. This kind of evaluation of validity and practicality is important so that the media can be accepted by users and contribute optimally to the learning process.

Various platforms and technologies are also applied in the development of interactive learning media according to the needs and context of learning. Putra (2023) developed PowerPoint-based media with an R&D model of the DDD-E stage that has been proven to be valid and suitable for use in mathematics learning. On the other hand, Riyadi and Wibawa (2024) developed an effective Quizizz-based interactive learning media in PPKN learning in grade 5 elementary school. These two studies show that the selection of appropriate media and in accordance with the characteristics of the learning material can increase the effectiveness of the teaching and learning process. Technological innovations such as Quizizz also make it easier for teachers to make the learning evaluation process more interactive and interesting.

The use of interactive multimedia in science learning (IPA) is growing and has a positive impact on students' science literacy. Najib et al. (2023) recommend multimedia as an effective tool to deepen understanding of the solar system based on science literacy at the elementary level. Likewise, Yulia and Putri (2024) reported the effectiveness of augmented reality (AR) media based on Assemblr Edu in increasing the science literacy of grade VI students by 38%. The AR technology not only increases the understanding of concepts, but also students' interest in learning science materials. The use of

innovative media such as AR shows that the integration of advanced technologies can enrich the learning experience and support the development of more in-depth science competencies. In addition to AR technology, artificial intelligence (Artificial Intelligence) has also begun to be integrated in science learning media. Sufiyanto and Hefni (2023) stated that AI technology is effective in attracting interest and increasing students' science literacy through digital learning media and applications. AI integration allows for personalized learning according to students' needs and ability levels, making the learning experience more interactive and in line with the development of the 21st century. This research opens up opportunities for educators to utilize advanced technology in creating an adaptive and responsive learning process to individual student needs.

A learning approach that combines innovative media with an active learning model has also been proven effective in improving learning outcomes. Evalina et al. (2024) stated that the application of the Problem Based Learning (PBL) model combined with innovative learning media was able to significantly increase the science literacy of elementary school students. This approach not only increases student engagement in the learning process, but also fosters critical thinking skills and in-depth understanding of concepts. The PBL model combined with interactive media strengthens the role of students as active learners who are able to construct knowledge independently.

Alternative media such as interactive e-comics have also been used in science learning to increase students' engagement and science literacy. Filjinan et al. (2022) found that the use of interactive e-comics was very valid, practical, and effective with an N-gain value of 0.60. This media is able to make learning more interesting and make it easier for students to understand science concepts visually and narratively. Likewise, Purwaristi and Wahyudi (2024) reported the effectiveness of interactive comics based on the TGT model in improving the science literacy of grade IV elementary school students. The use of comic media provides a fun and contextual learning approach, thus helping to overcome boredom and foster an interest in reading. In the context of digital-based learning media, eXe Learning has also proven to be effective in improving the science literacy skills of grade IX MTs students. Febryana et al. (2021) showed a significant increase in the average score in the experimental group compared to the control group. This media supports concept learning and problem-solving through interactive features and virtual labs. This study confirms that the use of digital media equipped with virtual practicum facilities can be an effective learning alternative, especially for science materials that require an understanding of complex concepts.

Interactive multimedia based on science and character literacy also received special attention in the development of learning media. Safira and Nahdi (2024) reported that this kind of media is very valid, practical, and effective in improving the understanding of the material and the learning motivation of grade IV elementary school students. The approach of integrating character in science learning is important to form students' positive attitudes and values in an integrated manner. This is in line with character education efforts which are now the main focus in the national education system, so that learning media not only develops cognitive aspects, but also students' affective aspects.

Animation video-based media also showed positive results in science learning. Pratama et al. (2023) stated that the use of animated videos significantly improved the science literacy of grade IV students, as shown by the increase in post-test scores and t-scores that exceeded the t table. Animated video media is able to present learning materials visually and dynamically so as to help students understand abstract concepts in science. Thus, animated videos become an effective learning medium and can increase students' motivation and interest in learning.

The development of Construct 2-based science literacy media, as carried out by Hidayat (2024), also makes a positive contribution to improving the science literacy skills of grade V elementary school students. This media is able to improve learning outcomes with a very high category of science literacy ability. However, Hidayat (2024) also reminded the importance of considering the stability of internet connections and teacher assistance so that the use of media can run optimally. This shows that the successful implementation of digital learning media does not only depend on the quality of the media, but also on the technical aspects and learning support. In general, these studies underline

that the development of interactive learning media should be carried out systematically with a structured development model, such as ADDIE or R&D. Testing of validity, practicality, and effectiveness is an important stage before the media is widely used. Research by Kifron (2024), Wahyuningsih et al. (2022), and Putra (2023) shows that valid and practical media improve the quality of learning and make it easier for teachers to deliver material. A thorough evaluation of the media also helps identify the improvements needed to make the media fit the learning needs and characteristics of the students.

The use of innovative learning media must also be adjusted to the characteristics of the material and learning objectives. Riyadi and Wibawa (2024) emphasized the importance of choosing the right media to support effective and inclusive learning in the digital era. Media such as Quizizz which is interactive provides a fun learning experience while making the evaluation process more efficient. In addition, the integration of new technologies such as AR and AI further opens up opportunities to enrich learning media and increase student engagement. Finally, this study concludes that interactive learning media developed with an innovative approach can improve students' learning outcomes, interests, motivation, and science literacy. Teachers and media developers are advised to continue to innovate in creating learning media that is adaptive and according to the needs of students. The integration of the latest technologies, active learning approaches, and thorough evaluation of media are the keys to the successful implementation of learning media in primary and secondary schools. Thus, the development of interactive learning media not only contributes to the improvement of academic competence, but also to the formation of students' 21st century character and skills.

CONCLUSION

Based on the results of the systematic study and analysis of the Literature Review, it can be concluded that the use of interactive learning multimedia makes a significant contribution to improving the science literacy of elementary school students. Through the presentation of interesting and varied materials such as narrative texts, illustrative images, videos, audio, and interactive multimedia animations, this approach is able to help students understand abstract science concepts in a more concrete and meaningful way. Interactive multimedia also encourages student involvement in the learning process. This involvement can be seen from the activities of students directly responding to the content, completing interactive exercises, and participating in science-based simulations. Thus, the development and use of interactive learning multimedia can be used as one of the innovative solutions in overcoming low science literacy at the basic education level. The use of this media is in line with the needs of 21st-century learning which demands the integration of technology in the educational process and supports adaptive, interesting, and effective learning for all students.

Future research is recommended to explore the long-term impacts of interactive multimedia on different aspects of scientific literacy, such as inquiry skills and evidence-based reasoning. Moreover, studies involving a larger and more diverse sample population would strengthen the generalizability of the findings. Researchers are also encouraged to investigate the development of subject-specific multimedia tools tailored to different science topics in elementary curricula.

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