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EFFECTIVENESS OF CRITICAL AND CREATIVE THINKING SKILLS THROUGH MULTIMEDIA-BASED LEARNING MEDIA IN ELEMENTARY SCHOOL

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ABSTRACT

To knowanalyzing the effectiveness of multimedia-based learning media in improving critical and creative thinking skills in elementary school students.This study aims to analyze the effectiveness of multimedia-based learning media in improving critical and creative thinking skills in elementary school students. The research uses the ASSURE development model, which allows for the planning of technology-based learning media in a structured and appropriate manner. The results of the analysis showed an increase in the average value from 79.44% (pretest) to 87.22% (posttest), with an N-Gain test of 0.4398 (high category). The MANOVA multivariate statistical test revealed that the use of interactive multimedia has a significant effect ($p < 0.05$) on students' digital technology literacy, critical thinking skills, and creative thinking. In addition, the results of the student response test showed a level of media interest of 93.33% with very interesting criteria. This study highlights the use of multimedia-based media can improve students' critical and creative thinking skills. For example, interactive simulations can help students understand complex concepts, while learning videos can provide real-world examples of the material being studied. By providing interesting visual and audio stimulation, students are more easily engaged in the learning process, thus encouraging them to think more deeply and creatively. The results of the study confirmed the significant influence of interactive multimedia on digital technology literacy, critical thinking, and creative thinking skills. In addition, the level of media interest received a very positive response from students, indicating that interactive multimedia can create an interesting learning experience and support the mastery of 21st century skills. Therefore, multimedia-based learning media is an innovative solution to support a more effective, interactive, and relevant learning process in the digital era. Multimedia-based learning media is one solution to overcome this problem. Multimedia integrates various elements, such as text, images, sound, video, and animation, which can provide a more interesting and interactive learning experience. By utilizing multimedia, students can be invited to learn actively, solve problems independently, and develop their creative ideas.

KEYWORDS: Interactive multimedia, Critical thinking skills, Creative thinking skills

1. INTRODUCTION

The rapid development of information and communication technology (ICT) has had a significant impact on the world of education.(Xiao, Wu, & Hamari, 2021). In this digital era, education is not only required to convey knowledge, but also to develop 21st century skills, such as critical and creative thinking.(Rofiq & Nurwulandari, 2021). This ability is essential for students to face global challenges, both in everyday life and in the future. Unfortunately, the traditional education system still tends to focus on memorization and mastery of material without providing enough space to train high-level thinking skills. So there needs to be new innovation from teachers to develop interactive learning media during the learning process with students.

The rapid development of information and communication technology (ICT) has had a significant impact on the world of education.(Lilis & Iswara, Ulfah Setia Retnani, 2020). Access to information that is increasingly easy and broad has changed the way students learn and teachers teach.(Rivera & Garden, 2021). Technology now allows the integration of various learning methods that are more dynamic, interesting, and relevant to the needs of students in the digital era.(Cicchirillo, 2019). In this era, education is not only required to convey basic knowledge, but also to develop 21st century skills, such as critical and creative thinking.(Rahmayanti et al., 2022). Critical thinking helps students to analyze information, evaluate solutions, and make informed decisions.(Putri & Zulkardi, 2018). Meanwhile, creative thinking allows students to create new, innovative ideas.(Riyanto & Putri, 2019). This ability is very important for students to be able to face increasingly complex global challenges, both in everyday life and in competition in the world of work.

However, the traditional education system still tends to focus on memorization and mastery of material approaches only. This approach often provides less space for students to develop high-level thinking skills, such as analysis, synthesis, and to support the development of critical and creative thinking skills, teachers need to present learning media that are not only visually appealing, but also able to stimulate active student participation.(Contreras-Espinosa & Eguia-Gomez, 2022). Multimedia-based learning media, such as interactive videos, digital simulations, and educational applications, can be a solution to create an interactive and enjoyable learning experience.(Mohd Jamel Farihah, Ali Mohd Norawi, & Ahmad Nur Jahan, 2021). This media provides opportunities for students to engage in the learning process, explore various concepts independently, and connect theory with real-world applications.(Hidayat, 2019).

In addition, innovation in learning media must also consider the characteristics and needs of students in elementary schools.(Hidayah & Asikin, 2021). At elementary school age, students tend to have a high level of curiosity and require an approach that is able to combine visual, audio, and kinesthetic aspects.(Zaiyar, Rusmar, & Yuniarti, 2020). By utilizing technology effectively, teachers can create a learning environment that not only stimulates critical and creative thinking skills, but also fosters students' confidence to convey their ideas. This innovation is an important step in equipping students with relevant skills for the future.(Fernández, García, Gómez, Areces, & Rodríguez, 2019). At the elementary school level, the formation of critical and creative thinking patterns needs to start early.(Muhayimana, Kwizera, & Nyirahabimana, 2022). Elementary school-age children are in a stage of cognitive development that allows them to begin analyzing information, asking questions, and creating solutions.(Putri & Zulkardi, 2018). However, conventional teaching methods often only place students as passive recipients of information. This has the potential to hinder students' ability to explore new ideas, discuss in depth, and think creatively in solving problems.

Multimedia-based learning media is one solution to overcome this problem.(Matsumoto, 2016). Multimedia integrates various elements, such as text, images, sound, video, and animation, which can provide a more interesting and interactive learning experience.(Cicchirillo, 2019). By utilizing multimedia, students can be invited to learn actively, solve problems independently, and develop their creative ideas. In addition, this media can be adjusted to learning needs, thus providing flexibility for teachers in delivering materials. However, the use of multimedia-based media in elementary schools still faces various challenges. Many schools, especially in remote areas, still have minimal access to technological devices and internet connections. In addition, the limited competence of teachers in developing or utilizing multimedia is also an obstacle in implementing this method. Without adequate training and support, the potential of multimedia-based media cannot be optimally utilized in the learning process(Kizilaslan, 2019).

Studies show that the use of multimedia-based media can improve students' critical and creative

thinking skills.(Wijayanti & Basyar, 2016). For example, interactive simulations can help students understand complex concepts, while learning videos can provide real-world examples of the material being studied. By providing engaging visual and audio stimulation, students are more likely to engage in the learning process, encouraging them to think more deeply and creatively.(Tanti, Maison, Syefrinando, Daryanto, & Salma, 2020). The COVID-19 pandemic conditions some time ago have also changed learning patterns globally, including in Indonesia. Distance learning that utilizes technology has shown the importance of innovation in teaching methods. This is a momentum to utilize multimedia-based media as part of the learning process, not only as a substitute for face-to-face, but also as a tool to improve the quality of learning.(Voogt & McKenney, 2017). Therefore, empowering critical and creative thinking skills through multimedia-based learning media is an urgent need.(Voogt & McKenney, 2017). By utilizing the potential of existing technology, elementary schools can create a learning environment that is more innovative, enjoyable, and relevant to students' needs.(Nurwidodo, 2020). This will support the creation of a generation that is ready to face global challenges and contribute to the nation's development in the future.

2. METHOD

2.1. Research Design

This study uses the ASSURE development model. The selection of the ASSURE model is used in media development research in the form of educational technology. ASSURE has several advantages, including: (1) can be used on a large or small group scale, (2) planning the use of media in class is carried out in real terms and according to needs, (3) makes teachers active in finding and optimizing media because it has complex components. This is in line with the opinion of Heinich, et al (2011:111) the characteristics of the ASSURE development model are that it combines all instructional activities, as follows: (1) begins with arousing student interest, (2) displays material according to teacher needs, (3) learning activities involve the active role of students so that feedback arises, (4) carries out an evaluation stage to assess the effectiveness and efficiency of the learning program

2.2. Population and Research Sample

The population in this study were elementary school students at SDN Tawangarjo, Malang Regency. The population of this study was 18 students. Sample selection was carried out by considering adequate representation of the entire population.

2.3. Sampling Techniques

The sampling technique used was purposive sampling (Cresswell et al., 2003). The purposive sampling technique was chosen because this study requires samples who have direct experience in art education in elementary schools. Inclusion criteria include teachers who have taught art education in elementary schools. The purposive sampling technique ensures that the selected sample is relevant to the research objectives and can provide in-depth information (Cresswell et al., 2003).

2.4. Data Collection Instruments

Data collection instruments used in this study include observation sheets, questionnaires and tests.

2.5. Validity and Reliability f Instruments

The validity of the instrument is tested through content validity by involving experts in the field of education to assess the suitability of the test items with the concepts being measured (Cresswell et al., 2003). The construct validity test is carried out using confirmatory factor analysis.

3. RESULTS

3.1. Interactive Multimedia Validity Results

Interactive multimedia is said to be feasible if it has gone through the assessment stage by several experts. The validation stage is carried out by material experts and media experts, namely lecturers at the State University of Malang. The purpose of the validation process is to assess the validity and feasibility of the product before it is used for field trials. Interactive multimedia is said to be feasible according to Wijaya et al., (2018) is clear in its instructions for use so that users are not confused, then the accuracy of the navigation buttons, the accuracy of the images, the suitability of the colors, and the suitability of the composition between text, audio, images and videos. This is in line with the validation guidelines made by researchers for testing the validity of materials and media.

The validation test of the material has several points that are measured, including the suitability of the material, learning and interaction. The point of suitability of the material explains whether multimedia is in accordance with competencies, indicators, objectives and whether multimedia is in accordance with the presentation of content (images, audio, animation, video). The learning point contains whether multimedia is able to help students in receiving information, whether multimedia

encourages students to find the right answers, whether multimedia makes students more active, and whether students are easily able to operate multimedia. The last point is interaction, in this point the contents are whether multimedia is able to make students learn independently, whether multimedia is able to attract students' attention, and whether multimedia has a response to the questions given.

The media validation test is said to be feasible if the indicators assessed achieve results in accordance with the expected criteria. The indicators assessed include safe multimedia, not easily damaged, durable, clear instructions for use, does not require much time, the combination of media colors is not distracting and attractive, each button functions properly, uses easy-to-understand language, clear font size, suitability of the material with each animation, video, image, and audio.

The material expert gave a score of 62 out of a maximum total of 62 with a percentage of 100% and entered the criteria for a very valid level of eligibility. Meanwhile, the media expert gave a score of 56 out of a maximum score of 56 with a percentage of 100% and entered the category of very valid or suitable for use as a learning medium and can be tested in the field. This is the same as in previous research by Dewi et.al (2023) that the results of the validity test reached 87.5% and could be said to be feasible so that a field trial could be carried out. Another study conducted by Sari., N. et al (2022) the results of the validity test obtained an average percentage of 92.5%. Similarly, the level of eligibility criteria according to Riduwan (2015) multimedia is declared feasible if it is in the presentation category between 81% and 100%.

3.2. Results of Interactive Multimedia Effectiveness

3.2.1 Interactive multimedia effectiveness data

Effectiveness data is obtained from learning evaluation before using interactive multimedia (Pre-test) and learning evaluation after using interactive multimedia (Post-test). The pretest and posttest results data are in table 1 below.

Table 1: Multimedia Effectiveness Data

No	Name	Pretest	Posttest
1.	ARH	90	100
2.	ABNR	70	90
3.	AAHW	80	90
4.	FM	90	100
5.	IAK	80	80
6.	IM	70	70
7.	KNA	70	80
8.	KPP	70	80
9.	MIEA	80	100
10.	MRF	80	90
11.	NSD	70	70
12.	RWNA	90	90
13.	RA	90	90
14.	SEPR	70	80
15.	SAZ	90	90
16.	SSAU	60	70
17.	VDQ	90	100
18.	WANN	90	100
	Amount	1430	1570
	Average	79.44	87.22
	KKM	75	

Based on table 1, the pretest results of class IV SDN 4 Tawangargo reached a score of 1320 with an average score of 79.44%. The lowest score was 60 and the highest score reached 90. While the posttest score reached a score of 1570 with an average score of 87.22%. From a total of 18 students, the results of the posttest activity reached the highest score of 100 and the lowest score of 70. After obtaining the results of the pretest and posttest, the effectiveness was tested through the NGain test. Based on table 2, the results of the Ngain test obtained a high category with a total of 0.4398. So it can be concluded that the use of interactive multimedia has a high level of effectiveness.

Table 2: NGain Value Data

Information	Mean Value	Category
Gain	0.4398	Tall

From the evaluation of learning after using interactive multimedia, there are indicators of success used to determine students' abilities in the aspects of digital technology literacy, critical and creative thinking skills. Indicators of success obtained when using interactive multimedia carried out by students. The results of indicators of success in digital technology literacy skills are presented in table 3. The results of indicators of success in critical thinking literacy skills are presented in table 4. The results of indicators of success in creative thinking literacy skills are presented in table 5. The success of indicators of literacy skills, critical and creative thinking skills are presented in the form of a bar chart in figure 1

Table 3: Indicators of Success of Digital Technology Literacy Skills

No	Student Name	Pretest		Posttest	
		Achievement Indicator Score	Mark	Achievement Indicator Score	Mark
1.	ARH	13	81	16	100
2.	ABNR	12	75	13	100
3.	AAHW	11	69	13	100
4.	FM	15	94	15	94
5.	IAK	14	88	14	100
6.	IM	12	75	12	100
7.	KNA	12	75	14	88
8.	KPP	10	63	12	94
9.	MIEA	12	75	16	100
10.	MRF	12	75	15	100
11.	NSD	11	69	13	100
12.	RWNA	13	81	15	100
13.	RA	15	94	15	88
14.	SEPR	12	75	14	100
15.	SAZ	15	94	15	94
16.	SSAU	11	69	13	100
17.	VDQ	16	100	16	100
18.	WANN	15	94	15	100
	Amount	231	1444	256	1600
	Percentage	80.21		88.89	

Table 4: Indicators of Success of Critical Thinking Skills

		Pretest		Posttest	
No	Student Name	Achievement Indicator Score	Mark	Achievement Indicator Score	Mark
1.	ARH	14	88	15	88
2.	ABNR	15	94	16	100
3.	AAHW	14	88	13	100
4.	FM	15	94	15	100
5.	IAK	12	75	15	94
6.	IM	14	88	13	94
7.	KNA	15	94	16	100
8.	KPP	14	88	14	94
9.	MIEA	12	75	14	94
10.	MRF	14	88	16	100
11.	NSD	12	75	13	100
12.	RWNA	13	81	15	100
13.	RA	12	75	14	100
14.	SEPR	13	81	14	100
15.	SAZ	12	75	13	100
16.	SSAU	11	69	13	100
17.	VDQ	13	81	12	94
18.	WANN	13	81	13	100
	Amount	238	1488	254	1588
	Percentage	82.64		88.00	

Table 5: Indicators of Success of Creative Thinking Skills

No	Student Name	Pretest		Posttest	
		Achievement Indicator Score	Mark	Achievement Indicator Score	Mark
1.	ARH	14	70	16	95
2.	ABNR	15	75	17	100
3.	AAHW	16	80	18	100
4.	FM	16	80	19	100

5.	IAK	16	80	17	90
6.	IM	16	80	19	100
7.	KNA	18	90	20	100
8.	KPP	17	85	19	100
9.	MIEA	13	65	14	100
10.	MRF	14	70	17	100
11.	NSD	17	85	19	90
12.	RWNA	17	85	17	100
13.	RA	13	65	15	100
14.	SEPR	19	95	20	100
15.	SAZ	15	75	17	95
16.	SSAU	19	95	20	100
17.	VDQ	17	85	20	100
18.	WANN	16	80	14	100
	Amount	288	1440	318	1590
	Percentage	80.00		88.00	

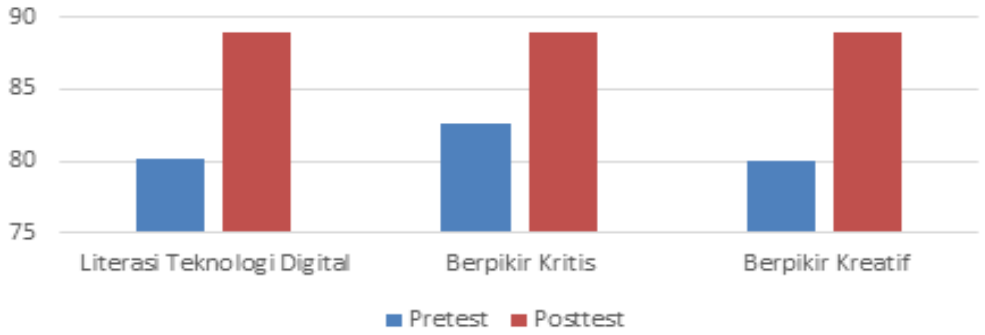

Figure 1: Diagram of Ability Success Indicators

This study is a development research, but there are results of the influence of the use of interactive multimedia that need to be studied. The results to be studied are the results of the influence of the use of interactive multimedia on digital technology literacy skills, critical thinking skills and creative thinking skills in grade IV Elementary School students. The sample of this study was 18 grade IV students of SDN 4 Tawangargo. The experimental group to test the effectiveness consisted of 8 students, while the control group consisted of 9 students. Therefore, for the research hypothesis, a statistical test needs to be carried out.

The calculation using the statistical requirement test in this study uses the normality test and homogeneity test on each variable in working on the evaluation questions on the use of interactive multimedia. The normality test in this study uses the Liliefors test, while the homogeneity test uses Shapiro Wilk. The calculation of the requirement test with the help of the Statistic Package for Social Science (SPSS) version 26 application.

3.2.2. Normality Test

The normality test is used in research to determine whether the distribution of the data to be tested is normal or not. The criteria for this test are based on decision making if the resulting distribution gets a p value> 0.05 then the value is distributed normally multivariate. Meanwhile, if the distribution is not multivariate normal then the p value obtained is <0.05. Table 6 explains that the results of the normality test on digital technology literacy skills, critical and creative thinking show a significant value> 0.05 so that the value is distributed normally multivariate.

Table 6: Shapiro-Wilk Normality Test

Ability Variable	Group	Statistics	df	Significant
Digital Literacy	Pre-Experiment	0.934	9	0.521
	Pre-Control	0.868	9	0.117
	Post-Experiment	0.907	9	0.297
	Post-Control	0.880	9	0.158
Critical thinking	Pre-Experiment	0.905	9	0.280
	Pre-Control	0.915	9	0.335
	Post-Experiment	0.897	9	0.236
	Post-Control	0.906	9	0.287
Creative Thinking	Pre-Experiment	0.940	9	0.586
	Pre-Control	0.937	9	0.553
	Post-Experiment	0.926	9	0.442
	Post-Control	0.882	9	0.163

3.2.3. Homogeneity of Variance Test

The homogeneity test of variance in MANOVA is to use the results of Levene's test with a criterion test that shows a significant value of >0.05, then the H0 value is accepted, namely the data has the same variance, while H0 is rejected if the significant value is <0.05. Table 7 describes the significant results getting >0.05, then the H0 value is accepted so that the further test used is Bonferroni.

Table 7: Lavene Homogeneity Test

Ability Variable	Mean	Lavene Statistics	df1	df2	Significant
Digital Literacy	Based on Mean	1,052	3	32	0.383
Critical thinking	Based on Mean	0.775	3	32	0.517
Creative Thinking	Based on Mean	0.812	3	32	0.497

3.2.4. Homogeneity of Covariance Test

The homogeneity test of covariance can be seen from the results of the Box's M test on the SPSS application with the criteria for the value of the test results of significant values >0.05, then the H0 value is accepted, namely the data has the same covariance, while H0 is rejected if the significant value is <0.05. Table 8 describes the significant results of getting 0.928> 0.05, then the H0 value is accepted so that the data has the same covariance.

Table 8: Homogeneity of Covariance Test

Box's M	F	df1	df2	Significant
11,883	0.545	18	3618.55	0.938

After knowing the prerequisite test and data normality test, the next step is hypothesis testing using MANOVA. MANOVA test is used to determine statistically significant achievement in three variables that occur simultaneously at one level. These variables include digital technology literacy, critical thinking and creative thinking. The hypothesis in this study is H0: There is no influence of interactive multimedia on digital technology literacy skills, critical and creative thinking. Hα: There is an influence of interactive multimedia on digital technology literacy skills, critical and creative thinking.

Multivariate test is the conclusion of the entire MANOVA test. The criteria for determining test results based on significance >0.05 then H0 is accepted and Hα is rejected so that there is no influence, while at a significance value <0.05 then H0 is rejected and Hα is accepted so that there is an influence. Table 9 describes the significant results getting <0.05 then the H0 value is rejected and Hα is accepted so that in this study there is an influence of interactive multimedia on digital technology literacy skills, critical and creative thinking.

Table 9: Multivariate Tests MANOVA

	Design	Value	Significant
Class	Pillai's Trace	0.658	0.003
	Wilk's Lambda	0.449	0.003
	Hotelling's Trace	0.992	0.002
	Roy's Largest Root	0.595	0.002

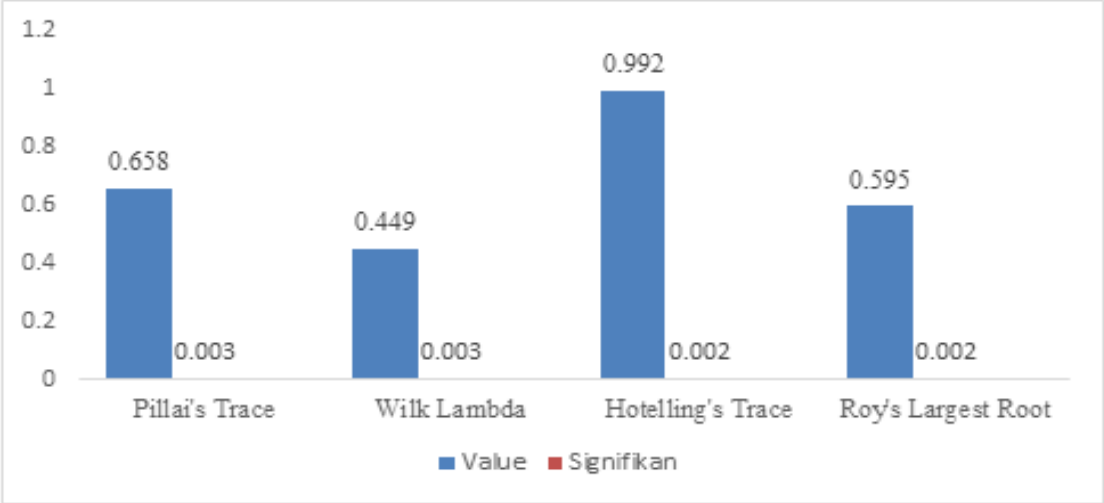

Figure 2: MANOVA Test

3.3. Interactive Multimedia Attraction Results

The interactive multimedia attractiveness test is data collection from student responses. The purpose of this is to determine the level of interest in interactive multimedia. According to Long. C., & Nie. Z. (2021) interactive multimedia is the latest information technology that helps students acquire and explore knowledge, integrates various interesting media and information and is able to increase students' enthusiasm for learning. Therefore, the level of attractiveness of interactive multimedia innovation is then measured by students answering several questions, regarding whether this interactive multimedia is easy and interesting to operate.

The student response trial has the following criteria, whether the media can be used easily, whether the instructions for use can be easily understood, whether the material is displayed clearly, whether the material is presented completely, whether the text is clear, whether the media is interesting, whether the material can be understood easily, whether the language used is easy to understand, whether the audio presented is interesting, whether the images used are interesting. The media is said to be interesting if the user response score falls into the criteria of 85% - 100%, this is found in the research of Wulandari, et al (2019) who obtained user response results reaching 94% which is very interesting. In the multimedia trial, the student response score reached 168 out of a maximum total of 180, with a percentage of 93.33% with the criteria of very interesting. So it can be said that interactive multimedia is interesting to grade IV students of SDN Tawangargo.

4. DISCUSSION

Various choices of educational technology can be used to develop learning materials according to the needs and characteristics of students. One of these learning technologies is interactive multimedia which is included in digital literacy. Interactive multimedia has several advantages, namely the use of technology and the delivery of information can be done by students independently and creatively which is adjusted based on the characteristics of the class students. Interactive learning developed with the help of Smart Apps Creator will be easier to use and increase student motivation in the learning process (Fauziyyah et al., 2023). The use of interactive multimedia makes it easier for students to be creative in learning and understanding the material. In addition, interactive multimedia can improve digital technology literacy skills, critical thinking and creative thinking of grade IV elementary school students.

Interactive multimedia is innovated to help educators in conveying information about the material on the application of Pancasila values in everyday life. The creation of this multimedia is intended for grade IV elementary school students. Interactive multimedia is suitable for use in schools in the learning process. This multimedia has a lot of content to help convey information. In line with the opinion of Mutlu-Bayraktar et al. (2019) that learning

Multimedia involves three or more media, namely speech or sound, images or diagrams and text. Interactive multimedia has the advantage of being accessible offline, easy to use and able to insert images, videos, animations, quizzes and feedback as well as teaching materials that are not

available in printed teaching materials in general, thus producing innovative multimedia (Yuberti, et al., 2022; Elviana & Julianto, 2022). Learning using interactive multimedia provides students with the freedom to choose the material they want to learn. The material contained in the media is packaged in an attractive, complete and concise manner so that students can obtain information effectively and efficiently. Agree with(Jain and Rogers, 2019)Helping students acquire and explore knowledge, integrating various media, providing various information, and being able to increase students' enthusiasm for learning. So that students get a meaningful learning process and feedback so that students experience an increase in critical thinking, creativity, and learning motivation. In line with(Baidil and Somakim, 2020)In the use of interactive multimedia, students are able to improve critical thinking, creative skills and problem solving skills.

The feasibility of interactive multimedia is based on the results of innovation, appeal, and effectiveness. The results of feasible development are determined through valid interactive multimedia results that can be used en masse as learning media, the level of appeal is used to show the ease and appeal of interactive multimedia and the level of effectiveness is used to see the influence of interactive multimedia when used as learning media.

Interactive multimedia is said to be feasible if it has passed the assessment stage by several experts. The validation stage is carried out by material experts and media experts, namely lecturers from the State University of Malang. The purpose of the validation process is to assess the validity and feasibility of a product before it is used for field trials. Interactive multimedia is said to be feasible according to(Azid et al., 2022)clear in the instructions for use so that users are not confused, then the accuracy of the navigation buttons, the accuracy of the images, the color match, and the consistency of the composition between text, audio, images, and video. This is in line with the validation guidelines created by researchers to test the validity of materials and media.

The material validation test has several points that are measured, including the suitability of the material, learning and interaction. The point of suitability of the material explains whether multimedia is in accordance with competencies, indicators, objectives and whether multimedia is in accordance with the presentation of content (images, audio, animation, video). The learning point contains whether multimedia is able to help students in receiving information, whether multimedia encourages students to find the right answers, whether multimedia makes students more active, and whether students are able to operate multimedia easily. The last point is interaction, at this point the content is whether multimedia is able to make students learn independently, whether multimedia is able to attract students' attention, and whether multimedia has a response to the questions given.(Twiningsih et al., 2024)

The media validation test is said to be feasible if the indicators assessed achieve results in accordance with the expected criteria. The indicators assessed include safe multimedia, not easily damaged, durable, clear instructions for use, does not require much time, the combination of media colors is not disturbing and attractive, each button functions properly, uses easy-to-understand language, clear font size, suitability of material with each animation, video, image, and audio.(Sukri, A., Rizka, M.A., Purwanti, E., Ramdiah, S., & Lukitasari, 2022).

The material expert gave a score of 62 out of a maximum total of 62 with a percentage of 100% and entered the criteria for a very valid level of eligibility. Meanwhile, the media expert gave a score of 56 out of a maximum total of 56 with a percentage of 100% and entered the category of very valid or suitable for use as a defense medium and can be tested in the field. This is the same as previous research conducted(Hashim et al., 2019)that the validity test results reached 87.5% and can be said to be feasible so that field trials can be carried out. Other research conducted by(Kageyama et al., 2022)The results of the validity test obtained an average percentage of 92.5%. Likewise, the level of eligibility criteria according to Retnawati et al., (2018) Multimedia is declared feasible if it is in the presentation category between 81% and 100%.

The effectiveness of interactive multimedia is obtained from the results of student evaluations by testing the effectiveness of the product through pretest and posttest activities. The results of the two tests are compared and then concluded as the final results. According to Akcaoğlu et al., (2023) With a percentage of 85% -100%, interactive multimedia is included in the very effective criteria.

According to Lombardi et al., (2021) Interactive multimedia is said to be effective if there is an increase in the pre-test and post-test scores, or student scores before using multimedia and

student scores after using interactive multimedia. The pre-test results reached a score of 1430 with an average of 79.44%. The post-test reached a score of 1570 with an average score of 87.22%. From the results of the analysis of the NGain test results, the results were 0.4398 with a high category. The conclusion in the pretest to posttest activities was that there was an increase in the average number so that interactive multimedia was said to meet the effective criteria. This can be seen from the increase in learning outcomes and testing the average results of the use of interactive multimedia in learning activities.

The interactive multimedia immersion test is a data collection from student responses. The purpose of this test is to determine the level of interest in interactive multimedia. According to(Amirian et al., 2023)Interactive multimedia is the latest information technology that helps students gain and explore knowledge, combines various media and interesting information and is able to increase students' enthusiasm for learning. Therefore, the interactive multimedia innovation is then measured for its attractiveness through how students answer several questions, regarding whether this interactive multimedia is easy and interesting to operate.

The student response test has the following criteria: whether the media can be used easily, whether the instructions for use can be easily understood, whether the material is displayed clearly, whether the material is presented completely, whether the text is clear, whether the media is interesting, whether the material can be understood easily, whether the language used is easy to understand, whether the audio presented is interesting,

Are the images used interesting? Media is said to be interesting if the user response score falls within the criteria of 85%-100%, this is found in research(Indrasiene et al., 2020)Getting user response results reaching 94% which is very interesting. In the multimedia trial, the student response score reached 168 out of a maximum total of 180 with a percentage of 93.33% with very interesting criteria. So it can be said that interactive multimedia is interesting for fourth grade students of SDN Tawangargo.

5. CONCLUSION AND RECOMMENDATIONS

The use of multimedia-based learning media is effective in improving the critical and creative thinking skills of elementary school students. The test results showed a significant increase in student learning outcomes, with an average posttest score higher than the pretest score and a high N-Gain category. The MANOVA test showed a significant effect of interactive multimedia on digital technology literacy, critical thinking skills, and creative thinking skills. In addition, the level of media appeal received a very positive response from students, this shows that interactive multimedia can create an interesting learning experience and support the mastery of 21st century skills. Therefore, multimedia-based learning media is an innovative solution to support a more effective, interactive, and relevant learning process in the digital era.

6. CONFLICT OF INTEREST

The author hereby declares that there is no conflict of interest.

REFERENCE

Amirian, S. M. R., Ghaniabadi, S., Heydarnejad, T., & Abbasi, S. (2023). The contribution of critical thinking and self-efficacy beliefs to teaching style preferences in higher education. *Journal of Applied Research in Higher Education*, *15*(3), 745–761. https://doi.org/10.1108/JARHE-11-2021-0441

Azid, N., Ali, R. M., El Khuluqo, I., Purwanto, S. E., & Susanti, E. N. (2022). Higher order thinking skills, school-based assessment and students' mathematics achievement: Understanding teachers' thoughts. *International Journal of Evaluation and Research in Education*, *11*(1), 290–302. https://doi.org/10.11591/ijere.v11i1.22030

Baidil, & Somakim. (2020). Creating category Higher Order Thinking Skills (HOTS) exercise for high school students. In *Journal of Physics: Conference Series* (Vol. 1470). https://doi.org/10.1088/1742-6596/1470/1/012038

Cicchirillo, V. J. (2019). Digital Game Advertising (IGA and Advergames): Not All Fun and Games. *Journal of Interactive Advertising*, *19*(3), 202–203. https://doi.org/10.1080/15252019.2019.1697126

Contreras-Espinosa, R. S., & Eguia-Gomez, J. L. (2022). Game Jams as Valuable Tools for the Development of 21st-Century Skills. *Sustainability (Switzerland)*, *14*(4). https://doi.org/10.3390/su14042246

Fernández, E., García, T., Gómez, C., Areces, D., & Rodríguez, C. (2019). Creativity and perceived multiple intelligences as predictors of scholastic aptitude in primary education. *Electronic Journal of Research in Educational Psychology*, *17*(49), 589–608. https://doi.org/10.25115/ejrep.v17i49.2597

Hafidhi, N. M., Hanafi, Y., Hadi, S., Suyitno, I., & Anggraini, A. E. (2024). Literasi Digital Siswa Sekolah Dasar: Penggunaan Bahan Ajar BERBASIS DIGITAL PADA PEMBELAJARAN BAHASA INDONESIA. Pendas : Jurnal Ilmiah Pendidikan Dasar, 9(2), 3019–3030.

Hashim, N., Saud, M. S., & Rahman, M. A. A. (2019). Evaluating the best-practice criteria of higher-order thinking skills for design and technology courses. *International Journal of Recent Technology and Engineering*, *8*(3), 7933–7936. https://doi.org/10.35940/ijrte.C6626.098319

Hidayah, I., & Asikin, M. (2021). The acceptability of concrete mathematics manipulative by children. In *Journal of Physics: Conference Series* (Vol. 1918). Mathematics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia: IOP Publishing Ltd. https://doi.org/10.1088/1742-6596/1918/4/042049

Hidayat, Z. (2019). Analysis of learning media in developing science textbooks with theme energy in life using integrated model for integrated 21st century learning. In W. C., A. B. S., F. S. dan M. Universiti Pendidikan Sultan Idris 35900 Tanjung Malim Perak, R. null, F. of M. and N. S. Universitas Negeri Padang Department of Physics, Jl. Prof. Dr. Hamka, Air Tawar, Padang, Y. null, … P. G. Universiti Pendidikan Sultan Idris 35900 Tanjung Malim Perak (Eds.), *Journal of Physics: Conference Series* (Vol. 1185). Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Padang, 25131, Indonesia: Institute of Physics Publishing. https://doi.org/10.1088/1742-6596/1185/1/012070

Indrasiene, V., Jegeleviciene, V., Merfeldaite, O., Penkauskiene, D., Pivoriene, J., Railiene, A., … Valaviciene, N. (2020). The critically thinking employee: Employers' point of view. *Entrepreneurship and Sustainability Issues*, *7*(4), 2590–2603. https://doi.org/10.9770/jesi.2020.7.4(2)

Jain, P., & Rogers, M. (2019). Numeracy as critical thinking. *Adults Learning Mathematics International Journal*, *14*(1), 23–33.

Kageyama, Y., Zamudio, S. Z., & Barton, M. (2022). Incorporation of simulation features to improve higher order thinking skills. *International Journal of Management Education*, *20*(2). https://doi.org/10.1016/j.ijme.2022.100628

Kızılaslan, A. (2019). The development of science process skills in visually impaired students: Analysis of the activities. *International Journal of Evaluation and Research in Education*, *8*(1), 90–96. https://doi.org/10.11591/ijere.v8i1.17427

Kuncahyono & Sudarmiatin. (2018). Development of Interactive Multimedia in Thematic Learning The Beauty of My Country for Class IV Elementary School Students, 3(2) http://journal2.um.ac.id/index.php/jktpk

Kuncahyono, & Sudarmiatin. (2018). Pengembangan Multimedia Interaktif Pada. Ilmu Pendidikan: Jurnal Kajian Teori Dan Praktik Kependidikan, 3(2), 156–163. https://core.ac.uk/download/pdf/287322336.pdf

Lilis, A., & Iswara, Ulfah Setia Retnani, E. D. (2020). The Effectiveness of Using E-Learning as Learning Media. *JKBM (Jurnal Konsep Bisnis Dan Manajemen)*, *7*(November), 72–81. https://doi.org/10.31289/jkbm.v7i1.4333

Matsumoto, T. (2016). Motivation Strategy Using Gamification. *Creative Education*, *07*(10), 1480–1485. https://doi.org/10.4236/ce.2016.710153

Mohd Jamel Farihah, Ali Mohd Norawi, & Ahmad Nur Jahan. (2021). Game-Based STEM Module Development for KSSM Science Teachers. *Journal of Turkish Science Education*, *18*(2), 249–262.

Muhayimana, T., Kwizera, L., & Nyirahabimana, M. R. (2022). Using Bloom's taxonomy to evaluate the cognitive levels of Primary Leaving English Exam questions in Rwandan schools. *Curriculum Perspectives*, *42*(1), 51–63. https://doi.org/10.1007/s41297-021-00156-2

Nurwidodo, N. M. A. I. I. S. S. (2020). European Journal of Educational Research. *European Journal of Educational Research*, *9*(3), 1089–1103.

Putri, R. I. I., & Zulkardi, Z. (2018). Higher-order thinking skill problem on data representation in primary school: A case study. In *Journal of Physics: Conference Series* (Vol. 948). https://doi.org/10.1088/1742-6596/948/1/012056

Rahmayanti, H., Ichsan, I. Z., Arif, W. P., Sa'diyah, R., Irwandani, & Fachrial, N. F. H. (2022). Higher-Order Thinking Skills of High School and College Students on Flood Mitigation. *Journal of People, Plants, and Environment*, *25*(1), 33–38. https://doi.org/10.11628/ksppe.2022.25.1.33

Rivera, E. S., & Garden, C. L. P. (2021). Gamification for student engagement: a framework. *Journal of Further and Higher Education*, *45*(7), 999–1012. https://doi.org/10.1080/0309877X.2021.1875201

Riyanto, B., & Putri, R. I. I. (2019). HOTS on mathematical modelling approach in primary school. In P. P.W. & J. R. S. Universitas Ahmad Dahlan Kampus IV (UAD) Kragilan, Tamanan, Banguntapan, Bantul, Daerah Istimewa, Yogyakarta (Eds.), *Journal of Physics: Conference Series* (Vol. 1188). Universitas Sriwijaya, Bukit Besar, Palembang, Indonesia: Institute of Physics Publishing. https://doi.org/10.1088/1742-6596/1188/1/012088

Rofiq, M. A., & Nurwulandari, I. (2021). The Development of HOTS-Basics Teaching Materials to Improve Student Analysis Skills. In *Journal of Physics: Conference Series* (Vol. 1842). https://doi.org/10.1088/1742-6596/1842/1/012072

Sa'dun, A. (2010). Model Pembelajaran Nilai Dan Karakter Berbasis Nilai-Nilai Kehidupan Di Sekolah Dasar. Jurnal Ilmu Pendidikan, Jilid 17(Nomor 1), 46–54.

Sasmito, A. P., Kustono, D., Purnomo, Elmunsyah, H., Nurhadi, D., & Sekarsari, P. (2021). Development of android-based teaching material in software engineering subjects for informatics engineering students. International Journal of Engineering Pedagogy, 11(2), 25–40. https://doi.org/10.3991/IJEP.V11I2.16299

Sukri, A., Rizka, M. A., Purwanti, E., Ramdiah, S., & Lukitasari, M. (2022). European Journal of Educational Research. *European Journal of Educational Research*, *11*(2), 859–872.

Tanti, Maison, Syefrinando, B., Daryanto, M., & Salma, H. (2020). Students' self-regulation and motivation in learning science. *International Journal of Evaluation and Research in Education*, *9*(4), 865–873. https://doi.org/10.11591/ijere.v9i4.20657

Voogt, J., & McKenney, S. (2017). TPACK in teacher education: are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education*, *26*(1), 69–83. https://doi.org/10.1080/1475939X.2016.1174730

Wijayanti, A., & Basyar, M. A. K. (2016). The development of thematic-integrated E-portfolio me-dia web blog based to increase the scientific literacy of elementary teacher education program's student. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 284–290. https://doi.org/10.15294/jpii.v5i2.7684

Wulandari, R., Susilo, H., & Kuswandi, D. (2017). Penggunaan Multimedia Interaktif Bermuatan Game Edukasi Untuk Meningkatkan Aktivitas Dan Hasil Belajar Siswa Sekolah Dasar. Jurnal Pendidikan, 2(8), 1024–1029. http://journal.um.ac.id/index.php/jptpp/

Xiao, R., Wu, Z., & Hamari, J. (2021). Internet-of-Gamification: A Review of Literature on IoT-enabled Gamification for User Engagement. *International Journal of Human-Computer Interaction*, *00*(00), 1–25. https://doi.org/10.1080/10447318.2021.1990517

Zaiyar, M., Rusmar, I., & Yuniarti, T. (2020). Correlation between Students' Mathematical and Logical Spatial Intelligence in Terms of Understanding Concepts. *Malikussaleh Journal of Mathematics Learning (MJML)*, *3*(2), 76. https://doi.org/10.29103/mjml.v3i2.3005

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