Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran
Volume 13 (2) 132 – 141 December 2023
ISSN: 2088-5350 (Print) / ISSN: 2528-5173 (Online)
Doi: 10.25273/pe.v13i2.17756
The article is published with Open Access at: http://e-journal.unipma.ac.id/index.php/PE

Macromedia flash-based interactive multimedia to increase elementary school students' scientific literacy in natural and social sciences

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Abstract: The development of macromedia flash-based interactive multimedia aimed to increase students' scientific literacy in the natural science subject material especially the characteristics of living things. This study used a 4D development model and employed a pretest-posttest control group design. The research data included the results of the validity, effectiveness of using macromedia flash-based interactive multimedia, and increasing students' scientific literacy after using macromedia flash-based interactive multimedia. The subjects of this study were fourth grade students at MI Muhammadiyah 1 Payaman, Lamongan. The validity consisted of material validity, design validity, and learning media validity from two experts. Meanwhile, the effectiveness of the media was perceived from the results of limited and field trials, as well as t-test and N-Gain test to investigate an increase in students' scientific literacy. The product was tested on fourth grade students in science subjects. The results showed that the percentages of the validity test of learning materials, media design, instructional media were 98%, 945%, 91.25% respectively with very valid categories. The result of the t-test was 0.001 <0.05 with the N-Gain test results of 73.44%, meaning that there was a significant difference and an increase in students' scientific literacy. It can be concluded that macromedia flash-based interactive multimedia is very suitable and effective as a medium for teaching natural sciences in elementary schools.

Keywords: interactive multimedia, macromedia flash, science literacy, natural and social sciences

Received 8 September 2023; **Accepted** 29 December 2023; **Published** 26 January 2024

Citation: AFSA, MZ., Mudayan, A., Khasanah, L.A.I.U., Widiyanti, W. (2023). Macromedia flash-based interactive multimedia to increase elementary school students' scientific literacy in natural and social sciences. *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, *13*(2), 132 – 141. Doi.org/10.25273/pe.v13i2.17756

INTRODUCTION

Information and computer technology has developed rapidly and makes a tremendous impact. The use of information technology and computers can be perceived in the development of computer-assisted learning media (Yelda Turkan , Frédéric Bosché , Carl T. Haas, 2012). Learning media is an important component in determining the quality of education, so teachers must choose the right methods and media. Learning media is a physical tool for conveying material (Siregar et al., 2020). The use of technology in the learning process can assist students in learning processes such as counting, reading, and enriching their knowledge. Therefore, teachers must be able to create interesting and communicative learning media for students (Syahputra & Maksum, 2020).

Education which supports future development is able to develop the potential of students, so that they can face and solve life's problems. Technology transformation in education is a wide-ranging topic for discussion and research (Scholkmann, 2021; Iivari et al., 2020). Educators must stay aware of the rapidly evolving developments in technology. Integrating and applying technology in learning practices have become a new trend for teachers (European Commission, 2019; Schmitz et al., 2022). Therefore, the role of the teacher is very important because it requires the teacher's pedagogical expertise in selecting what technology to use and how the technology can improve students' cognitive, affective, and psychomotor skills (Christina et al., 2020; Chien et al., 2016).

Interactive multimedia is a combination of various types of media (file formats) such as texts, images, and videos which are integrated in computer system applications so that they can be stored, processed, and presented simultaneously (Lestari, 2020). Interactive multimedia refers to a field of scientific and creative research which enables expression or communication through various media and have the ability to influence and change their context and content (Deliyannis, 2012). Interactive multimedia is made to convey materials and has interactive elements which allow users to communicate with each other (Li;, Ruobing, 2022).

Macromedia flash is a multimedia platform and software used to create animations, games, and internet enrichment applications which be played via Adobe Flash Player (Fahmi, 2014; Kusumadewi et al., 2013). Macromedia flash as a learning medium can help teachers and students in learning. This interactive multimedia can be used as a way to improve students' conceptual knowledge (Gunawan et al., 2014). Besides, this medium encourages students to manipulate ideas and increase scientific literacy because students can see learning in the real world.

According to AAAS (American Association for the Advancement of Science), scientific literacy is defined as knowledge and understanding of environmental events and occurrences, as well as the ability to use scientific knowledge, identify questions and draw conclusions based on evidence, so as to understand and help make decisions about the natural world and human interaction with nature (Americans, 1990). Scientific literacy has four components including (1) understanding of world situations which involves science and technology; (2) understanding of the natural world including technology on the basis of scientific knowledge, and knowledge of nature and science itself; (3) the ability to find scientific questions and explain scientific phenomena; (4) use scientific evidence as a basis for making decisions.

An independent curriculum is one that has many learning options and focuses on important material, so that students have sufficient time to learn concepts and strengthen their skills. In the era of society 5.0, various learning media are required. Grades I and IV of elementary schools use the Merdeka curriculum. Natural and social sciences learning is combined into Natural and Social Sciences (IPAS) subject. This policy was created to improve children's abilities to manage both the social and natural environment.

From the initial observations, it was obtained that the learning media used in IPAS was adequate, such as using a projector, teaching aids, and pictures. However, the use of technology-based media was not optimal and there was no media in the form of

applications or interactive multimedia. In fact, the use of learning media for science and social materials in the Merdeka curriculum is very important because it can help students to perceive real examples so that they can learn more concrete materials. Therefore, the use of macromedia flash interactive multimedia is required to convey messages and knowledge, especially in science subjects.

METHODS

Research Design and Procedures

The development of macromedia flash-based interactive multimedia was carried out using research and development (R&D) methods using the 4D development model proposed by Thiagarajan (1974). The design of this research can be perceived in figure 1.

The first stage (define) was carried out to determine and define the conditions needed in developing learning media. This stage consisted of five steps of analysis, namely the beginning and end, student analysis, student concept analysis, task analysis, and formulation of learning objectives. The second stage (design) discussed the media used. In this research it was macromedia flash-based interactive multimedia. This stage consisted of needs analysis, theme and sub-theme analysis, and interactive multimedia plan. The third stage (develop), macromedia flash-based interactive multimedia was produced. This stage consisted of testing the validity of learning media and media usage in the classroom. The final stage (disseminate) included a limited distribution through socializing the distribution of the media.

This research used experimental design with a control group. The treatment in the experimental class used macromedia flash-based interactive multimedia, while the conventional media was used in the control class. The design for testing the effectiveness of macromedia flash-based interactive multimedia can be perceived in table 1.

Participant and Material

The subjects in this study were students of MI Muhammadiyah 1 Payaman which consisted of two classes, namely class IV A and IV B. This research was conducted on the IPAS IV subject in the odd semester of the 2023/2024 academic year. The limited trial involved 10 students and the field trial involved 25 students in one class. The data collected in this study are data regarding the validity of interactive multimedia based on macromedia flash and the effectiveness of the media perceived through student responses. The control class and experimental class consisted of 25 students. The variables, data, instruments, and data analysis in this research are presented in Table 2.

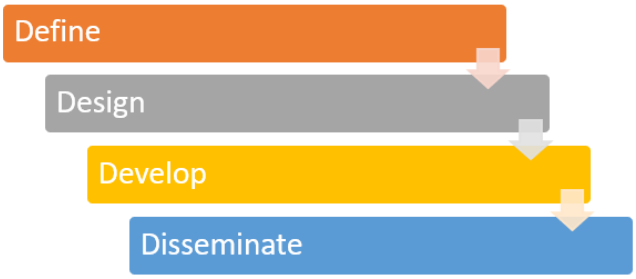

FIGURE 1. *Research method*

TABLE 1. *Control group pretest-posttest design*

Class	Pretest	Treatment	Posttest
Experimental	X_1	O	X_3
Control	X_2	-	X_4

TABLE 2. *Variabel, data, instrument, and data analysis*

Variable	Data	Instrument	Analysis
Media	Material Validation Results	Validity Sheet	Description of the validation criteria
	Media Validation Results	Validity Sheet	Description of the validation criteria
	Design Validation Results	Validity Sheet	Description of the validation criteria
	Validity Level	Scoring Rubric	Validation Description
Effectiveness	Limited trial percentage	Student responses and activities questionnaire	Description of student response
	Field trial percentage	Student responses and activities questionnaire	Description of student response
	Differences in the use of macromedia flash-based interactive multimedia	Literacy knowledge test	*Pretest-Posttest Control Group Design*
	An increase in IPAS literacy of students in elementary schools	Literacy knowledge test	*Gain Score Description*

Data Analysis

The data were analyzed by requesting validation from experts regarding the content in macromedia flash-based interactive multimedia. The experts filled in the provided validation questionnaire. They also provided input directly by writing it on the validation questionnaire sheet. Furthermore, limited trials and field trials were carried out to determine the effectiveness of the media. Finally, scientific literacy testing was carried out.

RESULTS

Development of macromedia flash-based interactive multimedia

The development of natural and social sciences learning media for fourth grade elementary school students produced macromedia flash-based interactive multimedia. This learning media aimed to increase elementary school students' scientific literacy in natural and social sciences. media display of the macromedia flash-based interactive multimedia is show in Figure 2 and 3.

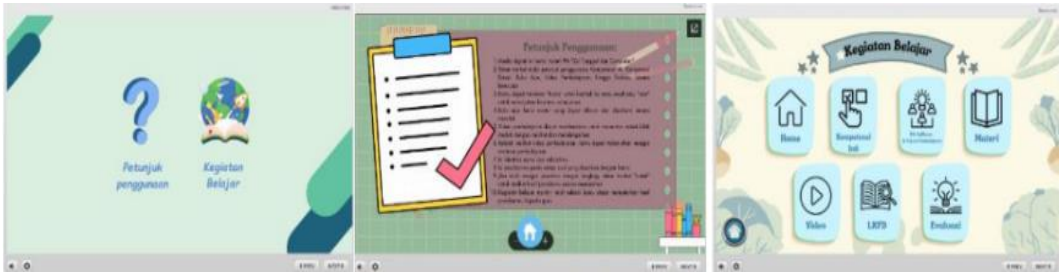

FIGURE 2. *Macromedia flash-based interactive multimedia*

FIGURE 3. *Macromedia flash-based interactive multimedia evaluation menu*

TABLE 3. *Validation results of material experts*

Aspects	Criteria	Scores	
		Validator 1	Validator 2
Materials	Curriculum	4.00	4.00
	Material	3.85	3.71
	Grammar	4.00	4.00
Percentage		**98%**	

TABLE 4. *Validation results of design experts*

Aspects	Kriteria	Scores	
		Validator 1	Validator 2
Design	Display design	3.78	3.42
	Video	4.00	4.00
	Animation	4.00	3.50
Percentage		**94.5%**	

TABLE 5. *Validation Results of Media Experts*

Aspects	Criteria	Scores	
		Validator 1	Validator 2
Media	Display Quality	3.80	3.70
	Software engineering	4.00	3.75
	Arrangement	3.00	3.50
Percentage		**91.25%**	

TABLE 6. *Limited trial results*

Subjects	Percentage	Category
Student responses	84.6%	Very good
Student activities	62.5 %	Good

TABLE 7. *Field trial results*

Subjects	Percentage	Category
Student responses	93%	Very good
Student activities	84.6 %	Very good

Validation results of macromedia flash-based interactive multimedia

Before conducting the trial, the media must be validated by experts. Media validation was carried out to determine its validity based on material experts, design experts, and media experts. The validation was carried out by two experts who were competent with natural and social sciences learning materials for elementary school students. Media validation results can be seen in tables 3, 4 and 5. Data on Table 3 indicate the total score percentage of material validation is 98% in the valid category. The learning materials used in macromedia flash-based interactive multimedia are in accordance with those in the curriculum. In addition, the use of language is appropriate and does not confuse students. Data on Table 4 indicate that the total score percentage of design validation is 94.5% in the valid category. The total average is obtained through several aspects including display design, video, animation designs. Data on Table 5 show that the total score percentage of media validation is 91.25% in the valid category. The total average is obtained through three aspects assessment including display quality, software engineering, and arrangement. After testing the validity of the material, design, and media, it can be concluded that macromedia flash-based interactive multimedia is very valid for use as science learning media in elementary schools.

The effectiveness of macromedia flash-based interactive multimedia

The effectiveness of macromedia flash-based interactive multimedia in elementary schools can be perceived from the results of limited trials and field trials. Limited trials were carried out on 10 students, while field trials were carried out with 25 students in one class. The results of limited trials and field trials can be perceived in Table 6 and Table 7. Based on the results of the limited and trials, there was an increase in the effectiveness of macromedia flash-based interactive multimedia in science subjects in elementary schools.

The effectiveness of macromedia flash-based interactive multimedia to improve elementary school students' literacy

At this stage, the researcher tested the effectiveness of the media to increase students' scientific literacy in science subjects. The test was carried out by conducting a pretest-posttest control group design experiment. The hypothesis tested was that students' scientific literacy in natural and social sciences using macromedia flash-based interactive multimedia was better than students who were taught using conventional media. Before testing the hypothesis, the data was initially tested for homogeneity and normality, and the results showed that the data was homogeneous and normally distributed. The results of hypothesis testing can be perceived in Table 8.

The data in Table 8 shows that in the pretest there is no significant difference in the experimental and control classes. The pretest in the experimental and control classes obtain an average score of 52.4 and 53.36 respectively. However, it is found a significant different in the experimental and control classes of 87.36 and 74.64 respectively. The value of Sig. 2 tailed obtained in both classes is $0.001 < 0.05$, so it means that H0 is rejected and Ha is accepted. Thus, it can be interpreted that there was a significant difference in the use of macromedia flash-based interactive multimedia in increasing students' scientific literacy in science subjects in elementary schools. The N-gain score is calculated based on the difference in the average pretest and posttest scores (Kharisma et al., 2023). Table 9 below shows the results of the N-gain scores for students' understanding of natural and social sciences concepts.

TABEL 8. *Hypothesis Test Result*

	Pretest		Sig.	Posttest		Sig.
	Experimental	**Control**		**Experimental**	**Control**	
Highest score	80	70		96	84	
Lowest score	36	38	**0.001**	74	60	**0.001**
Mean	52.4	53.36		87.36	74.64	

TABLE 9. *N-Gain Score*

	Experimental Class		Control Class	
N	25		25	
Rata-rata	52.40	87.36	53.36	74.64
Post-Pre	34.96		21.28	
100-Pre	47.60		46.48	
***N-Gain* (%)**	73.44		45.39	

The data in table 9 shows that the N-gain score for the experimental class is 73.44%, meaning that the N-Gain Score for the experimental class is "high". The N-Gain Score in the control class is 43.26%, meaning that the N-Gain Score in the control class is "medium".

DISCUSSION

Macromedia flash-based interactive multimedia is a learning medium developed through the Adobe Flash platform. Macromedia flash is an application which can create presentations, publications, or other applications which require user interaction (Prapti Utami & Rohaeti, 2019). The utilization of macromedia flash-based interactive multimedia can provide a different experience for students and teachers. In the revolutionary era 5.0, educational media-based technology is used to assist the learning process which can encourage students to better understand what they are learning (Sáez-López et al., 2020). Good learning material is relevant with the curriculum and adapted to the students' cognitive, affective, and psychomotor development stages, so that the material is easy to understand (Tegeh et al., 2019). The result of field trials in this research was 93% in the very good category. It can be concluded that the learning process will be more effective and easier for students to learn abstract science material by using macromedia flash-based interactive multimedia (Tsany et al., 2020; Sidik et al., 2020; MZ et al., 2021).

Macromedia flash-based interactive multimedia is effective to use in the classroom as it is evidenced by the results of the hypothesis test result (0.001 <0.05). In addition, the results of the N-Gain test showed an increase in student literacy of 73.44 %. This is because the material presented in the media is formed in an interesting way and is explained using real examples. Natural and social sciences learning using real examples is effective in developing understanding so that scientific literacy can increase (Safrizal et al., 2020; Amrullah & Suprapto, 2022; Winarni & Purwandari, 2019).

These results are in line with several previous studies which indicated that macromedia flash-based interactive multimedia has been proven to be effective in helping students in the learning process (Wahyugi & Fatmariza, 2021; Aquami et al., 2019). In addition, previous research showed that this media could increase students' scientific literacy (Kusuma, 2023; Meryastiti et al., 2023; William et al., 2020; Ati MZ et al., 2022). Furthermore, this media can promote student-centered learning. As a reference for carrying out the learning process, this information will be very helpful, especially for teachers at the elementary school level. Future research is expected to broaden and deepen research on the application of macromedia flash-based interactive multimedia to

students in elementary schools. Learning at the elementary school level is very important, therefore teachers must have the ability to carry out learning properly.

CONCLUSION

In conclusion, the results of the validity test of the material, design, and media show that the development of macromedia flash-based interactive multimedia produces learning media which can be used to increase students' scientific literacy. Limited and field trials show that macromedia flash-based interactive multimedia is very effective for students in elementary schools. The respondents indicate that the media is very good and can be used by teachers to improve students' understanding of scientific literacy as shown by the results of the t-test and N-Gain. Therefore, teachers can use interactive multimedia based on macromedia flash to support a more meaningful learning process.

ACKNOWLEDGMENTS

The researcher would like to thank Directorate of Research and Community Service, Ministry of Education, Culture, Research and Technology for the financial reports in this research through a research grant of *Penelitian Dosen Pemula* scheme in accordance with decision Number: 0557/E5.5/AL.04/2023 dated June 1, 2023. The researcher also would like to thank MI Muhammadiyah 1 Payaman, Lamongan who become our research site.

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