



Efforts to Enhance Scientific Literacy in Elementary School Students through Optimizing the Use of Digital Comics in Natural Science Materials in Elementary Schools

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Abstract. This study aims to explore the effectiveness of using digital comics to optimize scientific literacy in elementary school students. The experimental research method with a quasi-experimental design was adopted to collect valid and reliable data. This study involved students from several elementary schools, a total of 150 fifth-grade students at elementary schools randomly selected in the Laweyan Sub-district. After the control and experimental groups were assigned, the experimental group was given access to digital comics developed specifically to introduce natural science. Meanwhile, the control group did not receive special treatment in this regard. Data were collected through pre- and post-intervention knowledge tests and a questionnaire that explored students' perceptions of using digital comics. Data analysis employed analysis prerequisite tests, i.e., the normality and homogeneity tests and continued to test the hypothesis using statistical t-test analysis to identify significant differences between the experimental and control groups. The t-test results demonstrated that using digital comics significantly increased students' scientific literacy. The questionnaire results also revealed that students felt more interested and involved in learning natural science using digital comics, with a percentage of 89% included in the very good category. By utilizing this technology, educators and education service providers can increase scientific literacy related to nature, equip them with the necessary knowledge and skills, and prepare them optimally to deal with emergencies.

Keywords: Scientific literacy, elementary school students, digital comics, experimental research, use of technology

1 Introduction

The rapid global evolution heavily influences the development of the education sector. Currently, Indonesia must be ready to face the challenges of 21st-century education, which emphasizes students' critical analysis skills, creative ideas, collaboration, and good communication. At the elementary level, a 21st-century education approach is implemented through the 2013 Curriculum Framework, which combines subjects and reinforces character building. In elementary schools (SD), subject integration is carried

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M. Salimi et al. (eds.), *Proceedings of the 7th International Conference on Learning Innovation and Quality Education (ICLIQE 2023)*, Advances in Social Science, Education and Humanities Research 873,

https://doi.org/10.2991/978-2-38476-301-6_55

out through a thematic approach. For example, natural sciences are included in thematic learning.

The 21st century demands information and communication technology in everyday life, including education. Learning is vital in the 21st century to produce the best, most competitive, quality human resources. In 21st-century education, the focus is on teaching skills, an important part of human resource development, aside from teaching science. Learning skills are crucial from a 21st-century development perspective because of the development of technology and information, and everyone needs to have the knowledge and skills necessary to function in the 21st century.

Increasing the elements of self-learning demonstrated that scientific literacy is an appreciation of science so that they can contribute to the social environment. It is also assumed that scientific literacy influences students' decisions about personal and social issues. Today, more and more jobs demand high skills and require people who can learn, reason, think creatively, make decisions, and solve problems. Scientific literacy was first assessed in 1997 by the Organization for Economic Cooperation and Development (OECD) through the Program for International Student Assessment (PISA), and it was only put into practice beginning in 2000 (Sellar, 2014). PISA is an international survey that evaluates students' literacy in reading, arithmetic, and science at the 15 year old level (OECD, 2009).

As previously mentioned, the Program for International Student Assessment (PISA) of the Organization for Economic Cooperation and Development (OECD) measures scientific literacy abilities on a global scale every three years. In Indonesia, student scientific literacy is still relatively low, judging by the results of the Program for International Student Assessment (PISA) conducted by the OECD, which showed the ranking of Indonesian students' scientific literacy in 2000, 2003, 2006, 2009, 2012, and 2015. Respectively, Indonesia ranked 38th out of 41 countries (2000), ranked 38th out of 40 countries (2003), ranked 50th out of 57 countries (2006), ranked 60th out of 65 countries (2009), ranked 64th out of 65 countries (2012), ranked 62nd out of 70 countries (2015), and ranked 70th out of 78 countries (OECD, 2014; and 2018).

Based on PISA data, it can be said that scientific literacy in Indonesia is still relatively low. Several factors influence this. One of them is that students are not used to solving problems based on scientific expertise. Students are more accustomed to memorizing than understanding material, so they find it difficult to understand and apply it in everyday life. The next factor is that students usually do not want to answer questions in essays and prefer multiple-choice questions. This is because teachers often submit learning assessment questions that are not yet analytical in nature so that students cannot apply their reasoning.

Scientific literacy in Indonesia is also still relatively low, as in Odja's (2014) research, that the cause of the low ability of students' scientific literacy is because questions/tests oriented to science skills have not been introduced, such as PISA and TIMSS questions, and learning that trains science process skills has not been implemented, namely identifying scientific questions, providing scientific explanations of phenomena, and using scientific evidence. As with other studies conducted, it uncovered that the causes of students' low scientific literacy included subject matter that has

never been studied, students who are not used to working on questions that use discourse, learning processes that do not support students in developing their scientific literacy, and the learning habits of students in biology lessons which tend to emphasize aspects of understanding based on memory or memorization. In addition, inadequate school facilities lead to low scientific literacy competence in students.

The low scientific literacy that exists can certainly hinder students' skills in accepting learning at school, especially at elementary level schools, where students are introduced to science learning for the first time. Science learning at the elementary school level learning about nature or science is one of the topics of discussion that plays a key role in this training because science can offer something remarkably interesting to students. Therefore, appropriate learning methods are needed for students to acquire good qualifications and scientific knowledge based on technological advances to think logically and critically, be creative, assert correctly, and communicate and collaborate (Yulianti, 2017). Scientific literacy is also a skill in understanding scientific concepts and methods applied to solve problems and formulating conclusions based on evidence to understand and make decisions about natural phenomena (Arlis et al., 2020). Moreover, scientific literacy includes skills in creativity, communication, analytical thinking, and cooperation (Banila et al., 2021). In this context, students with scientific literacy skills can solve problems through scientific concepts, develop creatively simplified technologies, and make decisions based on community values and traditions (Pratiwi et al., 2019).

One way to enhance one's proficiency in scientific literacy is to invite students to read regularly. For students to be interested and accustomed to reading activities, it is necessary to plan reading activities that are entertaining and can attract students' interest. One form of entertaining and interesting reading media for students is comics. The entertaining content of comics makes it a favorite reading choice not only for children but also for adults. Comics are a popular type of reading material, consisting of images with text in dialogue bubbles that form a story (Nursholihat et al., 2017). The specialty of comics with a series of sequential images creates its appeal as a learning tool because it can describe events sequentially (Rosida, 2020). In line with this, Rosyida's (2019) research also explained that comics as a learning medium can be adapted according to the material's content and language appropriate for the learning context.

The use of digital comics can significantly increase scientific literacy for several main reasons. First, the rich visualization and engaging illustrations in digital comics have the potential to explain complex science concepts in a way that is easier to understand. It is immensely helpful in overcoming comprehension barriers that may arise when reading traditional scientific texts. Second, digital comics often combine strong narratives with visual elements, creating a more immersive and memorable learning experience. Third, digital comic technology allows multimedia integration, such as animations, interactive diagrams, or links to additional sources, which can support a more in-depth explanation of scientific concepts. Fourth, digital comics' visual and narrative engagement can stimulate interest in and enthusiasm for science, inspiring young readers to become more interested in the subject. Finally, the accessibility of digital comics through various devices and platforms allows wide dissemination of scientific literacy materials to various age groups and backgrounds (Gunawan, 2022).

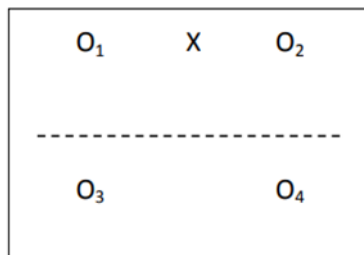
In this modern era, digital comics are particularly vital in increasing scientific literacy. Digital comics combine strong visual elements with compelling narratives and create an effective tool for explaining complex scientific concepts more understandably. The rich visualizations in digital comics can help visualize scientific phenomena, molecular structures, or natural processes that are difficult to explain with words alone. In addition, digital comics can often feature interactive aspects, animations, and additional media, enriching the learning experience and allowing readers to interact directly with the material being studied. Through this strong appeal, digital comics can stimulate interest in and enthusiasm for science, especially among children and youth. Accessing digital comics through various devices also enables the widespread dissemination of science literacy materials and creates opportunities for individuals from diverse backgrounds to enhance their understanding of science. By integrating technology and creativity, digital comics have the potential to become a powerful tool in creating a generation that is more informed and skilled in science (Saputro, 2017).

In this study, digital comics were chosen because they have advantages that are useful as teaching tools, such as attracting students' interest, enhancing the learning experience and assisting pupils in grasping abstract ideas. It is also done through a narrative that includes all the information. The material is organized in the form of illustrated storylines, and this learning method does not require internet access, making it easier for students to use digital comic learning materials independently without direction from the teacher (Kanti, 2018).

Based on the problems above, the researchers found that the scientific literacy abilities of students in elementary schools were quite low. Therefore, choosing the right media to improve scientific literacy in elementary schools in the Laweyan Sub-district is necessary.

2 Research Method

The main design in this study was quasi-experimental. In this study, researchers used a nonequivalent control group research design with the following design:



Description:

O_1 : Initial cultural literacy of the experimental class

O_2 : Final cultural literacy of the experimental class

O_3 : Initial cultural literacy of the control class

O_4 : Final cultural literacy of the control class

X : The treatment given, i.e., the think-pair project share model (Sugiyono, 2011).

A total of 50 students in this study were given a pre-test that tested scientific literacy before being given treatment in the form of fifth-grade learning with the theme 5 "Ecosystem," supported by digital comic media. The scientific literacy instruments employed in this research were competence (science process), science knowledge or content, and science context. The validity of the questions was tested using Pearson bivariate correlation (Pearson Product Moment) and reliability testing using Cronbach's alpha formula. Data collection techniques utilized tests to measure literacy skills. The stages in the validity test are as follows:

Content validity testing

The V-Aiken computation was used to conduct the content validity test. Expert judgment was used when administering the V-Aiken test. The values of the Aiken validity index vary from 0 to 1 (Budiyono, 2015). Seeking advice from professionals or those with experience is known as expert judgment. The test questions were deemed feasible to employ based on the average score of 0.891 obtained from the aspects measured.

External validity test

At this point, a sample unrelated to the research sample was used to test the instrument. It sought to identify a tool that could be applied to the whole population. The test's external validity was examined in two ways: its difficulty and its ability to distinguish between different answers. According to Budiyono (2015), the question's difficulty level is a numerical representation of the proportion of participants who properly answered the question for all students who attempted it. The difficulty index is between 0.00-1.0, with good results in the range of 0.30 (<) P (<) 0.70 (Budiyono, 2015). Meanwhile, the discriminating power of the question is the ability of the item to classify students according to their abilities. The criteria for a good item are if the difference power index is in the range of 0.30 (<) P (<) 0.70.

3 Results and Discussion

In the learning media trial, interactive PowerPoint was used to see the effectiveness of digital comic learning media on students' scientific literacy by giving students a pre-test (before treatment) and a post-test (after treatment). Based on field trials, scores were obtained from students' scientific literacy, as seen in Table 1.

Table 1. Results of the Science Literacy Trial

No	Range value	Frequency		Percentage	
		Pre-test	Post-test	Pre-test	Post-test
1	91-100	0	1	0%	
2	81-90	1	11	5%	
3	71-80	0	8	0%	
4	60-70	4	0	20%	
5	0-51	6	0	30%	
	Total	11	20	55%	

Based on Table 1, the data obtained from student learning outcomes revealed that students who scored 91-100 in the pre-test did not exist or 0%, while in the post-test, there was one student or 5%. Then, students who scored 81-90 in the pre-test were one student or 5%, while in the post-test, there were 11 students or 55%. While no students scored 71-80 on the pre-test or 0%, there were as many as eight or 40% on the post-test. Students who scored 60-70 on the pre-test were four, or 20%, while none or 0%, on the post-test. Furthermore, students who scored 00-51 on the pre-test were as many as six students or 30%, whereas there were none or 0% on the post-test.

The prerequisite test for the data obtained was carried out before testing the hypothesis. The prerequisite tests conducted consisted of normality and homogeneity tests. Based on the SPSS results, since a significant value of $0.200 > 0.05$ was attained, it can be said that the data in the experimental and control groups were distributed normally. Based on the data processing performed, the significance value was 0.431. After carrying out the prerequisite test, the researchers conducted a hypothesis test. In this study, researchers used parametric statistics to test the hypothesis because the data on student learning outcomes had a normal distribution. Based on the calculation results, the sig (2-tailed) was 0.027. Because the (2-tailed) value was smaller than the commonly used significance level of 0.05 ($0.027 < 0.05$), it can be concluded that there was a significant difference between the data on students' scientific literacy scores from the experimental and control classes.

4 Discussion

At the elementary school level, natural science has a significant role in the education system because it provides the knowledge students need to face various challenges in the global era (Yulianti, 2017). This situation calls for improvements in science teaching methods to achieve more efficient learning, especially at the primary school level, with greater emphasis on achieving scientific results, processes, and attitudes. It has great significance since the evaluation of scientific literacy, according to PISA (2006), is not only related to the subject matter but also includes context, knowledge (knowledge of science and knowledge of science), and attitudes.

Scientific literacy is one of the most important skills students in the 21st century must possess. Students with scientific literacy skills can implement the knowledge learned to solve problems properly in everyday life. Scientific literacy is also an individual's ability to use scientific knowledge and processes to make decisions about the universe (Jufrida., 2019). The concepts of science, the nature of science, and the relationships between science and society are highlighted by scientific literacy. The concept of science is needed because it has the function of understanding science and is the main key to solving a problem (Fausan., 2021). Therefore, in order to increase students' scientific literacy and critical thinking abilities, science education needs to grab their attention more. To do this, educational institutions should provide learning resources in the form of teaching materials that are designed to make the learning process and outcomes more meaningful (Karimah, 2021). In this case, comic media is one of the teaching materials or media that can attract students' attention to scientific literacy.

Digital comics are a valuable educational tool in elementary schools. Digital comics can increase students' scientific literacy (Nursolihat, 2017). Using illustrations in comics also helps students explain abstract objects more easily so that they are in accordance with the developmental level of students in elementary schools who are at the stage of concrete thinking (Buchori A. and Setyawati R.D., 2015). Here, educators can employ a variety of instructional resources to enhance learning activities and grab students' attention. Among the effective teaching materials that teachers can utilize in the teaching process is the usage of educational comics (ECm) and educational cartoons (ECr) (Şentürk, 2021). Daily newspapers typically feature comics as art, usually in color or black and white with words and pictures. Comics are also storytelling tools that tell unique stories in humorous or serious contexts and are presented in pictures and text. In comics, the story is told through a series of panels or frames that include multiple animations, such as word or speech bubbles, captions outside the panels, or sound effects and word pictures inside the panels (Badeo & Ong Kian Koc, 2021). Comics are a type of visual media that can draw in pupils because they allow them to read dialogue from characters and view graphics. Using comics in the classroom can help students become more motivated and interested in areas that they may find challenging, promote conversation, increase comprehension, and strengthen memory (Panjaitan, 2020). Through reading comics, children can develop a critical attitude, stimulate interest in reading, and provide direction to students who do not like reading so that they become more organized and diligent in reading activities (Rosyida., 2018). It confirms that using comics as a learning tool is the right step to increase student literacy. Comics can also function as a medium that makes it easier for students to imagine (Krisna., 2020).

A study on comic book usage as a teaching tool was conducted by Daulay (2018), who concluded that comic media could stimulate students, attract their attention, and help elementary school students in the learning process so that students could remember teaching material more easily. Using comics in the process of conceptual learning in schools brings a different approach to the learning process to support constructivism. Using comics in the learning process will produce a positive learning environment and create discussions among students when they analyze the images and problems generated by comics. Students are also allowed to share and expand on their ideas (Musa., 2020)

5 Conclusion

The t-test results uncovered that using digital comics significantly increased students' scientific literacy. Digital comics have proven to be an effective medium for connecting students with scientific concepts in a more fun and easier-to-understand way. The questionnaire results conducted from this study also strengthen these findings. Data from the questionnaire revealed that 89% of students responded positively to using digital comics in learning natural sciences. This percentage was in the "very good" category and indicated that students felt more interested and involved in the learning process through the application of digital comics. This technology could increase students' scientific literacy related to various scientific concepts by providing access to students to

learn through more interesting and interactive methods. Digital comics could equip them with important knowledge and skills in understanding nature. Digital comics could optimally prepare students for emergencies or challenges that may arise in the future. Therefore, applying this technology in an educational context has vast potential in advancing scientific literacy and preparing a more skilled and informed generation.

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