Digital comic teaching materials: It's role to enhance student's literacy on organism characteristic topic

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Abstract
The low level of scientific literacy of ninth grader (based on PISA score) is a trigger for science education researchers to carry out various innovations. In addition, changes in the educational platform in the new normal era, where technology becomes a mainstream, causes innovation in science education move towards providing digital technology-based media. The quality of science education at lower levels can be the cause of the low scientific literacy of students. By the reasons, the study aims to develop digital comics on the growth and development of living things for science learning in the elementary school. The media was developed on the basis of scientific literacy. The enhancement of students' scientific literacy was then investigated on using quasi-experimental research methods with a two-group pre-/post-test design. The research subjects were third-grade students from one of the private schools at Padang City, West Sumatra, Indonesia. The experimental class selected was class III B with 19 students consisting of 12 male students and seven female students, while class III A is a control class. The results show that digital comics media are very interesting and make children fun, because apart from an attractive appearance with fun colors, it also displays a storyline that brings children into the story world. The use of the context of everyday life causes children to easily follow the story line. Science content is presented as an explanation of the context presented. Competence or thinking skills are trained through questions in the narrative. This comic also touches on the positive side of attitude, about good and bad in context, so that it can invite children to choose and be responsible for choices. The results of the implementation show that the use of digital media can effectively increase the average score of scientific literacy in the experimental class, which is significantly higher than the average score in the control class. Further studies are needed using more and more diverse subjects to ensure the sustainability of the effects of using digital comics on students' scientific literacy.

Keywords: digital comics, living things, scientific literacy, science learning

INTRODUCTION

Development demands an increase in the quality of human resources who can compete in all fields, including education. This education system is responsible for creating individuals with high levels of literacy and scientific knowledge skills (Allen, 2020; Tabroni et al., 2022). The current literacy field is known as the digital reading era. Furthermore, digital reading is a process that involves the ability to navigate hypertext pages, understand or integrate various sources of information, and evaluate information (Anyanwu &

Contribution to the literature

- This research aims to examine the impact of using digital comics regarding the topic of organisms characteristics on students' scientific literacy in elementary schools.
- The use of digital comics made with Cartoon Story Maker software increased the effectiveness of learning on energy-saving theme materials.
- Digital comic representations of educational content have been shown to improve students' comprehension, creativity, and narrative coherence.

Grange, 2017; Salmerón et al., 2018). In other words, it is an era, where most people are more interested in reading through digital instead of print media.

In science education context, this era should be captured as an opportunity to develop the quality of the learning process (Gjelaj et al., 2020; Sanetti & Collier-Meek, 2019). Nowadays, teachers observe that children prefer to play with digital technology (Chalkiadaki, 2018; Saputri et al., 2018). Therefore, teachers need to anticipate this in science learning. They also have to think about necessary innovations based on digital reading in order to improve the scientific literacy of the students (Chen & Liu, 2018; Lin et al., 2020). The teachers realize that Indonesian students still have difficulty achieving scientific literacy scores, compared to children in other countries (Chusni et al., 2019; Drew & Thomas, 2018).

The literacy results of Indonesian students based on the program for international student assessment (PISA) are in apprehensive condition. The scientific literacy of students is one of the aspects assessed in this program. Indonesia is one of the countries that consistently participate in PISA. Although their PISA scores showed a slight increase from 2000 to 2018, they have not been relatively good enough in all areas. The sharpest declines occurred in the fields of reading, science and math (OECD, 2019). The government, through the ministry of education and culture, has attempted to provide solutions in order to increase PISA score or assessment of Indonesian education. One of the solutions is the promotion of school literacy movement (Allchin, 2014; Roberts & Bybee, 2014).

Indonesia was introduced to scientific literacy in 1993 through an invitation from UNESCO. This was marked by the country's participation in the international forum on science and technological literacy for all held in Paris, as well as a subsequent workshop on the same topic in Tokyo, Asia, and the Pacific. Furthermore, scientific literacy began to be accommodated in the 2006 curriculum and it was more prominent in the 2013 curriculum through inquiry activities and a scientific approach (Amini & Sinaga, 2021; Suryanti et al., 2018).

Scientific literacy is important to students for the following reasons:

(1) the understanding of science offers the fulfillment of personal needs and joy that can be shared with anyone and

(2) every country around the world is faced with questions (Vieira & Tenreiro-Vieira).

Therefore, scientific information and a way of thinking are required to make decisions. Moreover, the interests of several people, such as air, water, and forests, need to be informed. One of the themes in thematic learning related to scientific literacy is the growth and development of living things whose material includes the explanation of the characteristics and development of living things.

Scientific literacy is also related to future competencies that should be possessed by students. Its application to students is an important factor in the era of increasingly rapid technology. This is because it makes their mindsets more selective and not easily eroded by false information (Chen & Liu, 2018; Wahyu et al., 2020). Students are expected to be able to face challenges in the digital era. A learning method that can prepare students to be proficient in science and technology, as well as to argue accurately, is therefore necessary (Sanetti & Collier-Meek, 2019; Yacoubian, 2018). Science plays an important role in creating a reliable and quality young generation in facing the challenges of the digital era. The scientific literacy of students can be seen from the understanding of science learning (Pan et al., 2018; Sutiani, 2021).

The purpose of learning science in elementary schools is to develop knowledge as well as an understanding of scientific concepts that are useful and applicable in everyday life. Scientific literacy is important because it is the ability to use natural science, identify questions, and make conclusions based on evidence. Therefore, it aims to understand and help make decisions about the environment as well as the changes through human activity (Bloom & Quebec Fuentes, 2019; Podgornik et al., 2017).

The low ability of students' scientific literacy is caused by the teachers' weakness in planning and implementing science learning. A deep observation by the researchers in class III elementary school showed most teachers only used PowerPoint media displayed through the in-focus during the learning process. In some cases, the lighting from the projector is very unclear, hence, the students have difficulty reading and observing. Conventional teacher-centered learning is still applied; therefore, the students are passive in conveying their ideas (Bintoro et al., 2022; Tribull, 2017).

Moreover, the existing learning model outlined in the teacher's lesson plan has not been implemented.

Besides the issues arising from teachers, the low level of scientific literacy among students is influenced by the ongoing COVID-19 pandemic in Indonesia (Ahied et al., 2020; Lestari et al., 2021). As a result, the educational process has shifted to online learning. One of the negative effects of this method is the limited learning media used by teachers. Teachers and students cannot observe or touch learning media that are concrete due to space and time limitation. Under these circumstances, of course, there should be an alternative to creating and developing media that are suitable for learning conditions.

Several things can be carried out to encourage and improve the scientific literacy of students (Ahied et al., 2020). Based on the results of the literature review and field observations in the elementary schools described previously, it is necessary to apply digital media-based science learning (Darmayanti et al., 2022; Fatimah et al., 2019). This will enable teachers to use it for both online and face-to-face (normal) learning in the future. One type of digital media that can be developed in lower grades, especially at the elementary school level, is digital comics.

Science comics are an alternative media for playing while learning (Rina et al., 2020). The provision of a fun learning experience can improve students' scientific literacy. In line with the role of comics in teaching is its ability to increase students' interest in learning. The following are the advantages of comics, as learning media:

(1) they have the ability to create interest,

(2) guide interest in reading that attracts students,

(3) serve as a bridge to grow interest in reading with the guidance of the teacher,

(4) they make it easy for children to understand interesting things in an abstract manner,

(5) develop the interest of reading in other fields, and

(6) the entire course of the comic story has a common direction, namely goodness.

Students require educational media that can pique their interest in reading the assigned readings. According to Aggleton (2019) and Syarah et al. (2019), students show a higher interest in learning how to use digital comics compared to printed books. The study also demonstrated that young children could detect and comprehend marine conservation when studying natural sciences through digital comics. Therefore, by utilizing the latest technology that stimulates students' interest in learning, the introduction of marine conservation can be effectively implemented. Bintoro et al. (2022) and Sari et al. (2021) emphasized that students need this media to improve their learning outcomes. It can be used to translate abstract concepts into concrete

by constructing their own learning experiences. (Karlimah et al., 2021) found that the mathematical skills of elementary school pupils' increased and improved after learning how to use moving comics based on digital literacy.

Students usually like comics because they display pictures in each story. Comics are pictures and symbols arranged in a specific order to convey information and achieve aesthetic responses from readers (Mustikasari et al., 2020; Terlouw et al., 2020). They are better known as digital comics when technology is incorporated into their design and preparation to make them more attractive and efficient. Digital comics are created and compiled using applications, such as Comic Life 3. The following are the benefits of its usage in teaching and learning activities:

(1) they increase readers' vocabulary,

(2) help students to understand abstract concepts or formulations,

(3) they can spark children's interest in reading other subjects, and

(4) all comic storylines have a common theme, such as kindness or other subjects (Bintoro et al., 2022; Tsai, 2017).

According to Habiddin et al. (2022) and Tribull (2017), the use of digital comics is a very efficient way to teach science in elementary schools. They can encourage active learning in pupils and improve academic results.

Digital comics are published digitally, consist of a single image or several parts. Furthermore, they have a harmonious reading path, visible frame, symbols, such as word balloons, and consist of a writing style that communicates visual meaning (Arya Pageh et al., 2020; Habiddin et al., 2022). This is in line with the purpose of digital comics, which is to translate verbal (written) sources, enable students to easily imagine the events contained in the picture, and express their ideas based on the accompanying narrative images (Lee et al., 2021; Terlouw et al., 2020). Therefore, this study aims to examine the impact of using digital comics regarding the topic of organisms characteristics on students' scientific literacy in elementary schools.

METHOD

This is a quasi-experimental study with a non-equivalent group pre-/post-test control design and the subjects were class III elementary school students. Those in the experimental group were 19 with 12 males and seven females. Meanwhile, the control group was carried out in a class with the same number of students. Learning about the growth and development of living things can be facilitated in this class by optimizing digital comic media using Comic Life 3 application. Moreover, the students learn to use methods and media appropriately. The data collection method used was a

Figure 1. Comic Life 3 application (Source: Authors' own elaboration)

multiple-choice scientific literacy ability test instrument on the topic of living things characteristics. It was administered to the students through pre- and post-test. Furthermore, an observation sheet was used as supporting data.

A class III of an elementary school was selected in a random semester of 2022 to participate in this study. The teachers and students were initially interviewed to understand more about how learning takes place, determine the needs of the kids, and meet the learning objectives. The test instruments were validated by five expert validators, and student trials were subsequently conducted. The instrument was analyzed to identify questions that may be explored on the samples or in small groups. A total of 39 multiple-choice questions were used and examined for validity, reliability, degree of difficulty, and differential power. It was developed using the study's measures of scientific literacy to examine how the use of digital comics affects students' scientific literacy skills in classroom. The data were subsequently analyzed using statistical tests, namely the normality test, as well as homogeneity and t-test (independent sample t-test).

This study examined how the created digital comics can aid learning. Digital comics that are based on problem-based learning (PBL) were selected because they encourage kids to learn while having fun. The students' scientific literacy is expected to improve as a result of skills that support the effectiveness of learning media. Digital comics were created for educational purposes using Comic Life 3 application. The experimental class employs this media in their learning, while the control does not. Pre- and post-test will be administered in both classes at the beginning and at the end of the learning process respectively. The resulting data will be analyzed using the designated analysis technique.

Figure 2. Characters (Source: Authors' own elaboration)

RESULTS

The preliminary results showed elementary students and teachers require materials and media for learning. It was found that some materials lacked illustrations in their presentation. However, for low grade students, there are illustrations or pictures in each text consisting of more than four paragraphs. The illustrated images are presented alongside text with the aim of complementing it and bringing it to life through visual images. The images used in books for class I, class II, and class III of elementary school should clarify the text and give an interesting impression on students, thereby reducing the likelihood of boredom when reading.

The outcome of this study is a comic learning media, which was developed to overcome the weaknesses. This book was compiled with PBL orientation to improve the scientific literacy of class III elementary school students on the theme of growth and development of living things. The learning media was developed using Comic Life 3 application. Comics are packaged in PDF, compact disks, stored in flash disk, and it can be shared via Bluetooth, share it, WA links, as well as e-mail. The characters shown in the comics are drawn by the teachers. The comic is arranged in a series of picture stories. These pictures are equipped with speech balloons while some are accompanied by narrative explanation. Comics are sequences of images that are arranged according to the purpose and philosophy of the creator in order to convey the story message. They are usually accompanied by appropriate lettering. Moreover, they are the arrangement of pictures or images and words to narrate a story or dramatize an idea.

Comics' Development

The step of designing digital comic begins by opening the Google Chrome application. Type www.comiclife3. The next step is to click on 'Comic Life 3 for Mac & Windows,' download the free trial, and proceed with the installation (**Figure 1**).

Meanwhile, the storyline is designed, and the characters are drawn using pencil 2B. The pictures are subsequently scanned using HP cam-scanner (**Figure 2**).
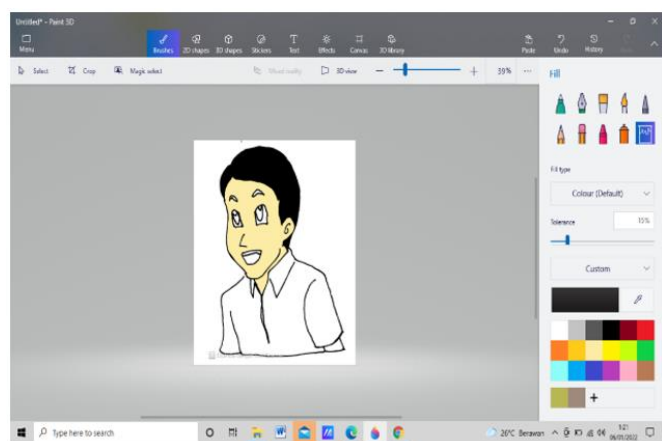
Figure 3. Insert pictures into Comic Life 3 application (Source: Authors' own elaboration)

The pictures are inserted into Comic Life 3 application after coloring. In the final step, the conversations are added using words balloon (**Figure 3**).

The presentation of the results and discussion will be carried out in three stages. The first stage will present the results of a qualitative analysis based on teacher interviews and curriculum analysis. The next discussion relates to the analysis of the cognitive instruments quality used. The last analysis is based on the discussion of statistical tests on students' scientific literacy skills.

Before implementing digital comics in the learning process, direct observations were carried out in the classroom and information was obtained from teachers through interviews. The interview results are shown in **Table 1**.

Table 2 consists of a list of questions asked during interviews with students to find out their responses on the use of digital comics.

The next analysis relates to the characteristics of students during learning. The observations results showed that there are four tendencies of students in using learning resources, namely

(1) they are lazy to read the material in books,

(2) they feel bored with learning,

(3) study time is limited but the learning material is solid, and

(4) students like illustrated reading.

These results serve as the basis for the use of digital comics in learning. This media has been previously developed and tested. The validity test of media experts showed that the developed media was very good with an average rating of 89%. Similar result was also obtained when the assessment was carried out by material experts, where it was declared content-worthy, with a percentage of 91% and 92% in terms of language. **Figure 4** shows a snippet of the media used.

In addition to ensuring that appropriate media are used, activities carried out during the pre-study include compiling and testing assessment instruments. The test results of the instrument quality indicate that the assessment tool used is valid and reliable in measuring students' abilities. Overall, there are 39 feasible and reliable questions.

Implementing lessons in the experimental class that makes use of digital comics. Each student utilizes a tablet to access digital comic books. In order to view the comics, a link is submitted in advance to the primary
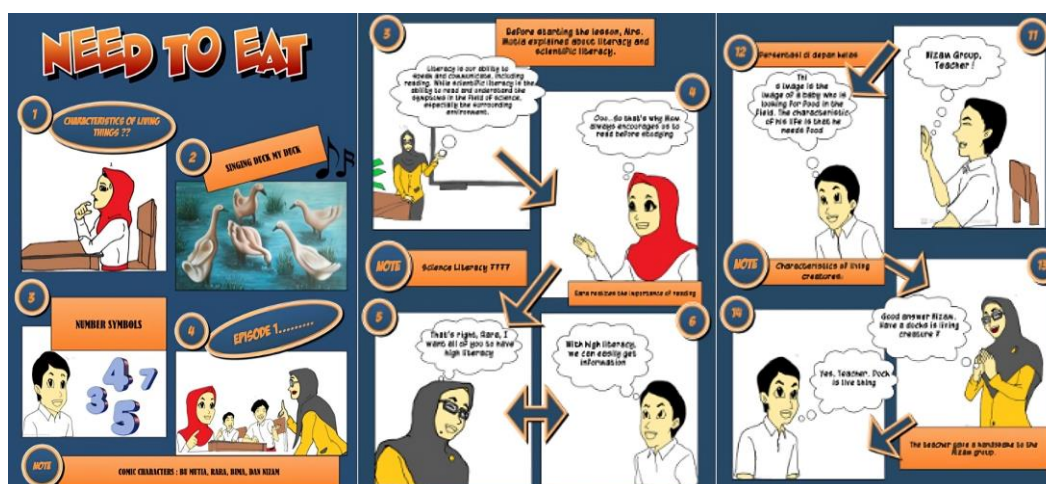
Table 1. Results of the interview with the classroom teacher

Question	Answer
Have you ever used digital-based media in your learning?	Once. But only PowerPoint media only. Incidentally currently, I do not use the media.
What method do you use when teaching?	I usually apply the lecture and question and answer method. Rarely use the learning model.
What difficulties did the students experience during the learning process?	They find it difficult to understand material for growth & development of living things. They look bored with story I tell. Maybe it is less interesting.
What difficulties did you experience during the learning process?	I have difficulty using appropriate media with the material. I am old, and not updated about the latest media. Therefore, I still teach using the lecture method and only use concrete media, in case of any.
What do you think, should this material be used in the form of digital comics?	Very good. We expect media like that here. Moreover, there are digital classes here, although they are rarely used due to limited ability of teachers.

Table 2. Guidelines for interviews with students

No	Questions	Percentage
1	Do you like learning with comics?	89% answered yes & 11% answered no
2	Are you interested in learning science by using comics?	92% answered yes & 8% answered no
3	Can you explain characteristics of living things after learning with comics?	73% answered yes & 27% answered no
4	Can you explain development of living things after learning with comics?	80% answered yes & 20% answered no
5	While using comics, has your interest in learning increased?	87% answered yes & 13% answered no
6	While using comics, has your literacy and science literacy increased?	77% answered yes & 23% answered no
7	While using comics, are your learning outcomes better than before?	83% answered yes & 17% answered no

Figure 4. Digital comic display (Source: Authors' own elaboration)

tablet of the teacher, who will subsequently share them with the students. A variety of scientific literacy domains are used after learning through the media. Most pupils are already inclined toward science. When a teacher conducts a test that involves reading and writing number names in the digital comics, it helps the students develop a more scientific mindset. Students are already becoming meticulous and careful in their responses to the names of numerals.

Moreover, the knowledge acquired reflects the subject matter or scientific literacy content. The students successfully complete quizzes and questions regarding the traits of living things depicted in pictures, long or short sound marks, and read the supplied number of thousands. Moreover, they demonstrate scientific literacy pertains to scientific procedures.

The issue is brought up by the teacher's photos, which the students' study before working in groups to share ideas on how the problem–when the ducks hunt for food while the farmers are harvesting, it would annoy them and harm the rice fields–can be solved. Scientific method is used by pupils when they identify issues and traits of living creatures that require food.

The students are allowed to ask questions about the course material after studying with digital comics in the experimental class. In line with the subject, evaluation question about scientific literacy is provided at the end of the class. The questions are administered via a Google form, which students can complete directly on their individual tablets. The evaluation questions are also distributed to the control group through a Google Form, whose URL was distributed via the class WhatsApp group. This is due to the limited time, which makes it impossible to provide an evaluation.

Media Implementation

Learning was conducted in school by using the developed media after confirming that the digital comic is suitable for use and measurement instruments are

Table 3. Summary of statistic test

Description	Pre-test		Post-test	
	Experiment	Control	Experiment	Control
Maximum	82.1	79.5	97.4	87.2
Minimum	69.2	66.7	84.6	79.5
Sum	1,446	1,456	1,703	1,562
Mean	76.1	76.7	89.6	82.2
SD	4.013	3.212	5.31	4.203
Homogeneity	0.460		0.363	
Normality	0.17	0.33	0.13	0.13
Sig. t-test	-0.673		2.033	

valid and reliable. Before starting the lesson, both the control and the experimental classes were given a pre-test to determine their initial abilities. Moreover, they were given a post-test as a final test. It was arranged in the form of a student literacy test using digital comics as a medium for learning science. This was administered to evaluate the scientific literacy of students who had used digital comics. The results of measuring students' abilities were further analyzed using descriptive and inferential statistics as shown in **Table 3**.

These data were obtained from the student's answer scores on the literacy test administered by the teacher. They were calculated based on the prerequisite test, namely the normality, homogeneity, and finally the independent sample t-tests. **Table 3** shows that the control class students had an average pre-test score of 76.7, lowest score of 66.7, highest score of 79.5, and standard deviation (SD) of 3.212. Meanwhile the experimental class students obtained an average pre-test score of 76.1, lowest score of 69.2, highest score of 82, and SD of 4.013.

Control class students obtained an average post-test score of 82.2, lowest score of 79.5, highest score of 87.2, and SD of 4.203. Meanwhile, experimental class students obtained an average post-test score of 89.6, lowest score of 84.6, highest score of 97.4, and an SD of 5.31. The increase in scientific literacy skills in the experimental class from pre-test to post-test is shown in **Figure 5**.
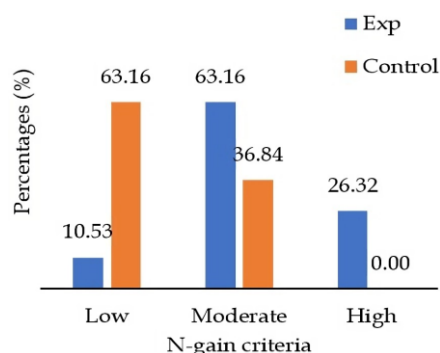
Figure 5. N-gain score (Source: Authors' own elaboration)

Figure 5 shows that the average score for the scientific literacy ability of the control class is 76.00 for pre-test and 82.00 for post-test. Meanwhile, the average value of the experimental class was 76.00 for pre-test and 90.00 for post-test. The result showed that the experimental class experienced an increase. This indicates that the effectiveness of PBL-based digital comic media is fulfilled based on the average post-test scores and N-gain calculations of the two samples.

DISCUSSION

Learning while having fun is the most important thing that parents and teachers look for in toys today. When the results of this study are looked at, it's clear that digital comics are a good way to both learn and have fun. When the participant reached the end of the experience in the comic digital, student had a new way of looking at things, learned something new, and had fun (Suwono et al., 2022). This finding fits with the ideas of the constructivist approach and educational trends like games and gaming.

Based on the interviews with students, the use of digital comics makes them happy to read and enables them to easily understand the contents, including the knowledge, skills, as well as attitudes embedded in them. The depiction of learning material in the form of comics makes it easier for students to understand the picture as a whole, builds their imagination, express their ideas in a good order, and tell story coherently (Gu et al., 2019; Habiddin et al., 2022). Digital comics are comics with electronic-based digital formats that display a coherent storyline, games, films, and animations. Other applications can also be inserted, making it easier for readers to follow and enjoy each story (Nguyen et al., 2018; Tsai, 2017).

Although comics serve as an entertainment medium initially, they can be integrated into educative reading material to help students understand a subject matter. Illustrations can affect the cognitive processing of the reader (Komalasari, 2019). Comics are a storytelling image medium, which allows students to be more helpful in understanding the material. Moreover, stories help the world as they teach about events that might have happened. The positive responses obtained in the use of digital comics make students focus more on understanding the material to construct conceptual understanding (Chen et al., 2018; Lazarinis et al., 2015).

Furthermore, the results in **Table 2** show that there is a strong need for innovation in terms of learning resources for elementary school students. Students feel happy and find comic media helpful in learning science because makes it easier for them to understand the characteristics of organisms in the material. They can learn while playing and still achieve learning goals. This finding is in line with the previous studies, which state that textbooks are now mostly in the form of textbooks. Although there have been variations in the addition of illustrations, there are no significant effect on increasing students' reading interest (Hilton, 2020; Piper et al., 2018; Støle et al., 2020). Low interest in reading causes a decrease in activity and learning outcomes. The complexity of the teaching materials presented makes them less interested in reading textbooks. This means that students' scientific literacy skills have increased in terms of how their views/perceptions of the digital comic media use as well as learning objectives are well achieved.

Comic digital representations of educational content have been shown to improve students' comprehension, creativity, and narrative coherence (Anindyarini, 2021; Suwono et al., 2022). Similarly, games, videos, animations, or other apps can be added into comics with electronic-based digital formats to depict a coherent storyline, making it easier for readers to understand and enjoy each story (Habiddin et al., 2022; Tsai, 2017). Vocabulary retention and comprehension of course topics are both improved with the usage of digital comics, particularly for students with a poor interest in reading. Every month, a student can read twice as many words as they would in a whole year of reading textbooks by reading comic novels (Anindyarini, 2021). Comics have the potential to make complex subject matter more approachable, and they can also help students become more critical consumers of media (Gu et al., 2019; Habiddin et al., 2022).

Table 3 shows that the significance value of the t-test is 0.413<t- table (2.016). Therefore, it can be concluded that there is no difference in the initial scientific literacy abilities of the experimental and the control class students. However, after learning through the digital comic media, the significance value of the t-test is 2,040>r-table (2.016). This indicates there is an effect of using digital comics in this study (Hilton, 2020; Mustikasari et al., 2020; Støle et al., 2020). Based on the data in **Table 3**, the average result of scientific literacy ability in the control class was 82.00 while the experimental was 90.00. This indicates there are differences in the results of scientific literacy skills for both classes.

The students were interested and highly enthusiastic during the use of digital comics because the media was being applied for the first time. Moreover, the interaction between teachers and students during the learning process becomes active, since learning is not only centered on the teacher (Alneyadi, 2019). The learning process, which is dominated by student activity, leads to the achievement of scientific literacy. This demonstrates that the understanding of scientific literacy has improved considering their opinions or impressions concerning the use of digital comic media and the success of theme 1's learning objectives. Its usage in the classroom has the advantage of fostering student-teacher interaction, making educational activities more successful and efficient. Moreover, information is easily conveyed to students in a manner that is engaging and easy for them to understand.

Next, **Figure 5** shows that the average score for the scientific literacy ability of the control class is 76.00 for pre-test and 82.00 for post-test. Meanwhile, the average value of the experimental class was 76.00 for pre-test and 90.00 for post-test. This indicates that digital comic media material is effective on the growth and development of living things and it can improve students' scientific literacy (Jufrida et al., 2019; Smaragdina et al., 2019). The result showed that the experimental class experienced an increase. This indicates that the effectiveness of PBL-based digital comic media is fulfilled based on the average post-test scores and N-gain calculations of the two samples.

CONCLUSIONS

This study successfully examined the effect of digital comics on increasing students' scientific literacy. The scientific literacy ability of students in the class treated with digital comics was higher compared to those in the control class who used printed books as teaching materials. The results showed the use of digital comics made with Cartoon Story Maker software increased the effectiveness of learning on energy-saving theme materials. The results of the data calculation showed that the sig paired samples statistics was 0.000 and the correlation value was 0.766. Meanwhile, the paired samples test sig 2-tailed was 0.000. This indicates that the use of the media has a significant influence on the learning process. The limitation of this study is that the use of digital comic is restricted to PDF files and not available in the form of new applications. This is because its creation involves a lengthy process and multiple applications. When presented in an animated format, it may resemble an educational video. The implication of this study is to increase students' scientific literacy due to the use of digital comics. By this conclusion, a follow up study is recommended to ensure that the media can be widely used, not only in one class, but in the broader region.

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