



Effectiveness of Digital Heat Teaching Materials Based on Science, Environment, Technology, Society (SETS) to Improve Science Literacy of Junior High School Students

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Abstract

Nowadays, students need scientific literacy to develop skills to deal with technological developments in the industrial era 4.0. According to several studies, the scientific literacy of Junior High School and Islamic Junior High School students in various regions in Indonesia is in the medium and low categories. Innovative teaching materials appropriate for use in online learning are digital teaching materials. The development of SETS-based digital teaching materials is one of the efforts to improve students' scientific literacy in an online learning. The purpose of this research is to analyze how the validity, readability, and effectiveness of SETS based digital heat teaching materials improve the scientific literacy of Junior High School students. The method employed in this research was the Research and Development (R&D). It took the research sample from seventh-grade students at State Junior High School 3 Juwana by selecting three classes totaling 90 students. The expert validation of teaching materials using expert judgment obtained a score of 93.18% and the proof of media experts received 92.65%, indicating that teaching materials were suitable for learning media. The readability test results to the teaching materials using the gap test showed that the teaching materials were easy to understand. The results of the N-gain test from the pretest and posttest scores obtained a score of 0.706, which indicated that the enhancement of student's scientific literacy was in the high category. Based on these result, it can be concluded that SETS-based digital teaching materials were effective in improving the scientific literacy of Junior High School students.

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INTRODUCTION

The rapid development of science in the industrial era 4.0 causes humans to adapt to all aspects of life, especially technology implementation. The world of education has its challenges in responding to changes in the number of applications of the latest technology (Cholily, 2019). Kagermann et al. (2013) said that it was necessary to involve academics in educational development to realize the industrial era 4.0 in a country.

Applying information and technology in education should develop scientific literacy and problem-solving skills to face future challenges (Supahar, 2020). The international organization OECD (2019) stated scientific literacy as a person's ability to apply scientific knowledge in real-world contexts. This is in line with Sammel (2014) that science literacy-based learning provides opportunities for students to explore the interaction between content knowledge and the nature of science so that students are involved in a meaningful way to relate it to the life around them. Therefore, scientific literacy is essential for students to think and act to understand environmental problems, modern society, and the application of technology (Dewi, 2021).

Based on data from The Program for International Student Assessment (PISA) issued by the OECD (2019), students' scientific literacy in Indonesia scores 396, far below the OECD average score of 489, which means it is still relatively low. Hidayah (2019) found that scientific literacy skills in the competence domain of Junior High School / Islamic Junior High School students in Pati Regency were in the low category with an average percentage of less than 50%. Furthermore, Yanti's research (2020) on the analysis of scientific literacy of students at State Junior High School 2 Bua Ponrang, Luwu Regency, South Sulawesi, which is viewed from reading habits, learning motivation, and learning achievement, showed that the number of students who have scientific literacy in the low and shallow categories is 58.03 % of 112 respondents. The research results from Hasasiyah (2020) revealed that the scientific literacy of students of State Junior High School 4 Belik Pematang, Central Java, on blood circulation material is in a low category. Some

of these results mean that reinforcement and learning are needed to enhance scientific literacy with supportive learning approaches or media.

Many factors can cause the low scientific literacy of Indonesian children related to the educational process, one of which is textbooks as learning media (Maturradiyah, 2015). The development of innovative learning media is an alternative in improving students' scientific literacy by increasing their scientific process abilities. Research from Puspitasari (2021) in which the development of an interactive science e-book effectively increased the scientific literacy of junior high school students in Yogyakarta for aspects of knowledge and competence.

In addition to developing teaching materials, the SETS approach (Science, Technology, Environment, and Society) has proven to be an effective solution for developing new literacy. Applying the SETS approach can help students learn by connecting the four SETS elements that meet essential competencies and learning indicators (Rosana, 2019). Learning with the SETS approach combines the four elements derived from science, the influence of the surrounding environment, the application of technology, and the influence of the social environment of the community, which can increase a deep understanding of knowledge (Farda, 2018). The SETS vision was chosen and used to discuss the concept of heat matter from the (S) Science, (E) Environment, (T) Technology, and (S) Society side. As well as, STSE-based teaching materials in Lebanon emphasize the linkage of science with issues based on Science, Technology, Society, Environment with the increasingly complex scope of the problem as the grade level increases (Mohamad, 2021).

Many types of research have been carried out regarding the development of SETS-based and certain-based teaching materials, the latest breakthroughs to improve students' scientific literacy in Indonesia. The development of learning tools with the SETS vision of the outdoor learning method from Sugiyono's research (2017) can improve learning outcomes and the quality of science learning by increasing students' activity in learning. The development of thematic textbooks with the SETS vision can also improve the ability to master the concept of Sustainable and Renewable

Energy with the average students' activity during learning in the excellent category (Atmojo, 2018). The development of SETS teaching materials that contain religious values, namely I-SETS, has been proven to improve students' religious character, discipline, and responsibility after using teaching materials as learning media (Wahyuni, 2017). The latest research from Hardianti (2021), which developed teaching materials based on (SETS) on the motion system of living things, has been proven to improve the scientific literacy of class VIII students at State Islamic Junior High School 1 Mataram. Based on the description of the development of teaching materials, it showed that the development of teaching materials based on SETS has the potential to increase students' activity, character, care for the environment, and even scientific literacy.

One of the appropriate learning media used today is digital teaching materials. Besides being used for online learning, digital teaching materials can be an innovation in keeping up with the times for a more prospective future (Puspitasari, 2021). The observations at State Junior High School 3 Juwana, students at seventh grade used teaching materials in textbooks from the Ministry of Education and Culture of the Republic of Indonesia Revised Edition 2017. Printed teaching materials were deemed insufficient in improving students' scientific literacy. Printed teaching materials are also deemed inappropriate when used in online learning. The current demands for teaching materials lead to digital teaching materials that improve students' skills in using relevant information technology (Attamimi, 2021). Based on this needs analysis, this research aims to find out the effectiveness digital teaching material based on Science, Environment, Technology, and Society (SETS) to improve science literacy of students. The development of digital teaching materials is aimed at helping online learning that is currently taking place.

METHODS

The research site was State Junior High School 3 Juwana, Pati Regency, Central Java, by taking 90 students of seventh grade in academic year 2021/2022. The research method was Research and Development (R&D) with the ADDIE development

model, namely Analysis, Design, Development or Production, Implementation or Delivery, and Evaluations (Mulyatiningsih, 2011: 184). The stages of development are schematically described in Figure 1.

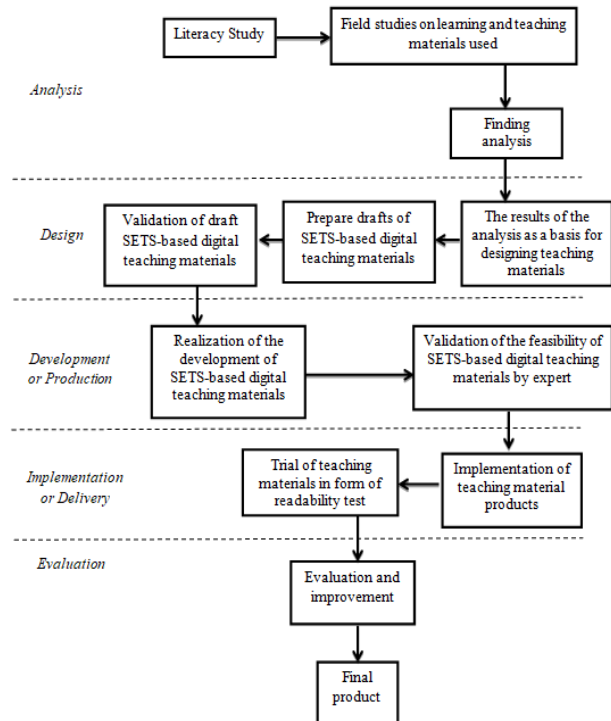


Figure 1. Research Flow of SETS-Based Digital Teaching Materials

Analysis of the validity and readability of teaching materials was calculated by adding up the scores achieved from all aspects assessed and then using the formula according to Sudijono (2014) as follows:

$$N = \frac{k}{Nk} \times 100\%$$

Explanation:

- N : Score percentage
- k : Achieved score
- Nk : Maximum score

The criteria for the percentage of the questionnaire validity results were then qualified into the assessment criteria in Table 1.

Table 1. The criteria validity of teaching materials (Akbar, 2013)

Interval of criteria (%)	Criteria
85 < N < 100	Very suitable
70 < N < 85	Quite suitable
50 < N < 70	Less suitable
1 < N < 50	Not suitable

The readability analysis of teaching materials showed the difficulty of teaching materials to be understood when used by students. According to Wahyuni et al (2017), the criteria of readability score by giving in Table 2.

Table 2. Classification of Teaching Materials Readability

Score (%)	Category
$0 < A \leq 40$	The teaching materials are difficult to understand
$40 < A \leq 60$	The teaching materials have met requirement
$60 < A \leq 100$	The teaching materials are easy to understand

The N-gain test was conducted based on the obtained pretest and posttest values. This test was used to determine the criteria for increasing students' scientific literacy based on pretest and posttest scores after using teaching materials as learning media. According to Kurnianto et al (2019), the regular gain formula and the N-gain criteria were as follows:

$$N - gain = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}$$

The standards applied to N-gain can be seen in Table 3.

Table 3. Range of scores and criteria for N-gain (Wiyanto, 2008)

Interval	Criteria
$g < 0.3$	low
$0.3 \leq g < 0.7$	medium
$0.7 \leq g$	low

RESULTS AND DISCUSSION

The teaching material developed in this study was one of the learning media, including heat material presented in the form of an e-book or flipbook that can be distributed online or offline. This digital teaching material contained 32 pages which consisted of an introduction, content, and closing. The introduction section had the front page, introduction, and table of contents. The content section contained apperception, learning objectives, heat material, material linkages related to daily tools

or activities, sample questions, misconceptions, and discussions. The end had a bibliography.

This digital teaching materials can be used easily online because they can be opened and read like reading a book at any time via a smartphone or laptop. It can also be opened offline using the Flip PDF Corporation application. According to Waller (2013), digital teaching materials such as e-books also had the advantage of being environmentally friendly, which does not require much paper to reproduce and can reduce costs for printing them. In addition, this digital teaching material was also quite interactive with a button that leads to a right or wrong explanation in misconceptions about heat material. The use of a combination of interactive text, images, videos, and animations has been proven to improve students' scientific literacy because it made students easier to understand the material being studied (Firdausy, 2017).

This SETS-based digital teaching material was equipped with videos that support the material so that students can better understand, be interested, and improve their scientific literacy. In addition to videos, there were also some additional SETS-based knowledge about the application of technology and examples of local community activities. Multidimensional science learning with integrated SETS can help students practice their scientific literacy skills (Zooler, 2013). Scientific literacy was closely related to the science material itself, the application of technology, the influence of the environment, and the surrounding community so that SETS-based teaching materials can improve students' scientific literacy (Hardianti, 2021).

Digital Teaching Materials Validity

Validation or validity was a research instrument level of correctness and rightness. Validity emphasizes observations or measurements in collecting the required information (Risnawati, 2021). The validity test of digital teaching materials in this study was carried out by two experts, namely material experts and media experts. A science teacher validated the material expert at State Junior High School 3 Juwana, who had a Master of Education degree, and the validation of the media expert was carried out by a lecturer at the Pati Engineering College (STTP) who had a Master's degree in Computer Science. The results of the

SETS-based digital teaching materials validity test were presented in Table 4. and Table 5.

Table 4. Expert Validity Analysis Results of SETS-Based Digital Teaching Materials

Suitable Aspect	Score (%)	Criteria
Content	87.5	Very suitable
Presentation	95.45	Very suitable
Total Percentage	92.65	Very suitable

Table 5. Expert Validity Analysis Results of Digital Teaching Materials Based on SETS

Suitable Aspect	Score (%)	Criteria
Graphic	94.4	Very suitable
Content Illustration	87.5	Very suitable
Total Percentage	93.18	Very suitable

Based on the results of data analysis, it found that the validity of SETS-based digital teaching materials by material experts was 92.65% and the validity of SETS-based digital teaching materials by media experts was 93.18%, which showed that SETS-based digital teaching materials were very suitable for being used as learning media for seventh grade students in heat materials. However, the design of teaching materials that obtained very valid results still received suggestions and comments from media experts and material experts. Based on suggestions and comments from media experts and materials experts, improvements were made to digital teaching materials by changing fonts, colours, and adding simulation videos for heat experiments.

The teaching materials have met several assessment criteria, including the use of fonts that were suitable for images and easy to read, writing appropriate titles, subtitles, and illustrations, using images that meet several aspects of the assessment, being easy to use, and assisting in teaching and learning process. The results of the development of digital teaching materials that support digitization obtained validation results of more than 95% fall into the category of very suitable for use in learning (Dewi, 2021).

According from material, the teaching materials that have been developed have met the

criteria for the feasibility aspects of presentation and content feasibility. The feasibility of presenting teaching materials has completed the systematic consistency of production, coherence of materials, references to several books that support and involve students' participation in learning using digital teaching materials. The feasibility of the content of teaching materials has met the completeness of the material contained in Core Competence (KI) and Basic Competence (KD), accuracy of pictures and terms, the accuracy of appropriate examples and photographs. Besides, it can improve students' knowledge and scientific literacy. Apart from being in the form of heat material, science in this digital teaching material was also given in the context of pictures, videos, and information about the application of technology and the phenomena of surrounding activities that form the basis of scientific literacy as a focus for social change and its impacts (Valladares, 2021).

Digital Teaching Materials Readability

The results readability of SETS-based digital teaching materials were obtained from the gap test scores carried out by students. The filling in the gaps in the reading section gives rise to reading activities. It was called readability. Based on the results of the readability test analysis of SETS-based digital teaching materials, a score of 67.32% was obtained, which was included in the category of easy-to-understand teaching materials. The results of the readability score indicated that SETS-based digital teaching materials have high readability so that they were easy to understand by readers.

Apart from the gap test, this study also looked at students' responses to the readability of digital teaching materials as learning media. The obtained score from the reaction to the readability of digital teaching materials was 24.7, which indicated that the teaching materials had good readability. Students' responses in using teaching materials showed that students quickly understood language, sentences, pictures and were more interested in learning heat using digital teaching materials equipped with animations and videos. Digital teaching materials with appropriate and interactive delivery of materials can help students learn independently using relevant teaching materials (H, 2021).

Teaching materials suitable for use as teaching media had good readability criteria and the selection of the correct language (Permatasari, 2021). Teaching materials that were easy to understand empowered students' thinking skills. The correct terminology and good readability supported a person's understanding of the text and increased his literacy (Ilmi, 2016).

The Effectiveness of Digital Teaching Materials in Improving Students' Scientific Literacy

The effectiveness of digital teaching materials in improving students' scientific literacy was obtained from the pretest and posttest scores. Multiple choice questions totalling 20 were given before (pretest) and after (posttest) treatment, namely learning using SETS-based digital teaching materials. Online learning and tests had several weaknesses, one of which was the supervision system for students when taking tests (Aji, 2021). Therefore, this research was conducted online but still brought children face-to-face learning with strict health protocols and permission from students' parents.

The increase in students' scientific literacy was obtained from the N-gain test of students' pretest and posttest scores using SETS-based digital teaching materials. This N-gain test compared students' scores before and after using digital teaching materials for heat materials. Comparing students' pretest and posttest scores using digital teaching materials can be seen in Table 7 and presented in graphical form in Figure 2.

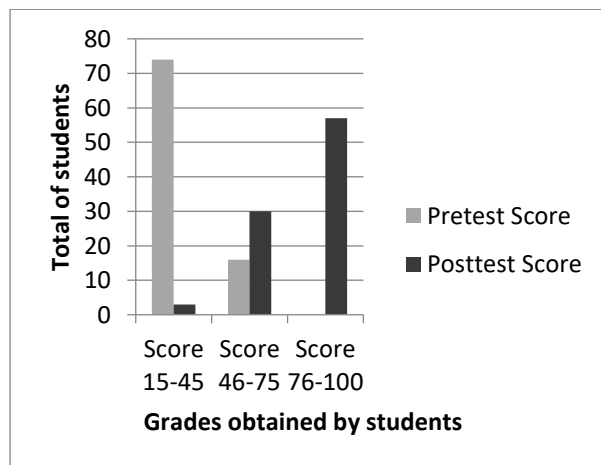


Figure 2. Comparison of pretest-posttest scores and many students

In Figure 2, it can be seen that the students who obtained the most pretest scores were in the range of 15-45, and there were no students who obtained the pretest scores in the range of 76-100. Students who obtained posttest scores in the range of 15-45 were the least, and most were in the range of values of 76-100.

Table 6. Comparison of students' pretest and posttest scores using teaching materials

Criteria	Pretest Score	Posttest Score
Minimum score	15	30
Maximum score	65	100
Average	35.27	80.94
N-gain	0.706	

Based on the data that has been obtained, the analysis of the N-gain test for increasing students' scientific literacy obtained a score of 0.706, which was in the high category. The high N-gain value of this study was because the posttest scores of the students, on average, got much higher scores than the pretest scores. This value meant that students had higher scientific literacy after using SETS-based digital teaching materials, so it can be said that SETS-based digital teaching materials effectively improved students' scientific literacy. I-SETS-based teaching materials, namely Islamic, Science, Technology, Environment, and Society with complemented characters, were proven to increase students' learning motivation, religious character, and care for the environment (Syarifah, 2019). Learning that involved an environment for contextual learning by utilizing science learning resources can help students better understand their scientific literacy (Kristyowati, 2019). STSE-based teaching materials that cover science, technology, social, environment, and culture have been successfully implemented in environment-based learning and have been proven to be effective in improving students' cognitive and affective domains because they can encourage students' scientific literacy to be applied in the real world (Tsang, 2021).

CONCLUSION

The validation results of material experts and media experts revealed that this SETS-based digital teaching material was very feasible to be used as a learning medium by obtaining a material expert validation score of 92.65% and media expert validation of 93.18%. The readability test obtained from the gap test and student responses showed that this digital teaching material was easy to understand. After a few additions and improvements, digital teaching materials were applied in a large-scale test to determine their effectiveness in improving students' scientific literacy. The results of the N-gain test obtained a result of 0.706, and several teachers and students' response questionnaires stated that SETS-based digital teaching materials were considered effective in improving students' scientific literacy. These SETS-based digital teaching materials could be a reference for other researchers or educators to develop creative and innovative digital-based teaching materials other than heat materials that could enhance students' scientific literacy.

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