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Learning Multimedia Based on Science Literacy on the Lightning Theme

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Abstract

This study aims to develop of multimedia-based literacy on the lightning themes and apply it on the science learning to improve of students' scientific literacy. The method used in this research is Research and Development with ADDIE (Analysis, Design, Development, Implementation and Evaluation) models. The research design at the multimedia implementation as small scale on the science learning by using one-group pretest-posttest design. Implementation was carried out in class IX with 31 students with cluster random sampling. The result of research showed: (1) multimedia based science literacy on lightning themes in the form of text, images, animation, and videos that refer to the 2015 PISA framework are content, science competencies and science attitudes domains; (2) the feasibility test by the expert and teacher show all aspects of multimedia have a very good category, it is suitable for use in science learning; and (3) the using of multimedia can increase science literacy skills especially content and scientific attitude domains have medium category. As well as competency domains show is very good categories. This is supported by respon of student that multimedia is very good in the domain aspects of literacy and motivation, whereas in aspect of operating multimedia have good categories.

Keywords: Multimedia, Science Literacy, Lightning

INTRODUCTION

Science Learning in schools does not only focus on understand knowledge, but science requires an understanding of scientific processes and scientific attitudes. Students' understanding of science, science processes, and science attitudes is contained in scientific literacy. A person who understands science will have the desire to include science and technology in social life that requires the ability to explain scientific phenomena, evaluate and design scientific research, and interpret scientific data and evidence (OECD, 2013). Similar opinions were expressed by Turiman, et al (2011) and Holbrook and Rannikmae (2009) that the problems of daily life can be solved by increasing the ability and creativity of science and scientific literacy.

Science literacy in PISA 2006 focuses on students' ability to clarify things that must be done in personal, social, and cultural contexts (Bybee et al, 2009). According to the OECD (2013), scientific literacy is characterized by four domains, namely the context domain (contexts), competence (competencies), knowledge (knowledge), and attitude (attitude). These four domains are interconnected and are expected to be achieved through the science learning process. A person's understanding of science gets regular assessments by the Program for International Student Assessment (PISA)

PISA evaluates scientific literacy every three years for junior high school students in advanced and developing industrial countries such as Indonesia. The results of the PISA assessment in 2015 showed that the achievement of science literacy in Indonesian students was still low with an average score of 500 from all participating countries (OECD, 2015). The results of the study by Rubini et al. (2016) showed that the achievements of scientific literacy from 25 science teachers were 20% of teachers had low literacy in science, 65% were in moderate category, and 15% in low category.

According to Toharudin (2010) the weak content of scientific literacy in science learning at the level of primary education is the cause of the lack of success of Indonesian students in TIMSS and PISA. The main weakness lies in aspects of scientific attitudes and science competencies (Arsyad, 2016). Efforts to improve scientific literacy have been carried out by Ardianto and Bibin (2016) using a guided discovery learning model and problem-based learning. The results showed an increase in achievement of scientific literacy with N-gain of 37% (guided discovery learning) and 41% (problem-based learning). Another factor that influences the achievement of

scientific literacy is that the use of teaching materials both printed and non-printed teaching materials has not been maximized.

The results of the analysis carried out by Ardianto and Pursitasari (2017) on three books that are often used in science learning in junior high school show that almost all books do not contain proportional aspects of literacy.), ways to investigate (49.98%), ways of thinking (44.44%), interactions between science, technology, and society (35.42%). Literacy aspects contained in the book are still dominated by science knowledge/content. The problem of not accommodating scientific literacy aspects in printed teaching materials has an impact on the low level of scientific literacy. This has been overcome by Putikah (2018) who has developed context-based fun science materials to improve students' scientific literacy. Teaching materials that can also be used in science learning are printed teaching materials in the form of multimedia.

The use of multimedia can reduce misconceptions and gain meaningful knowledge (Cepni et al. 2010, and Tatli & Ayas (2012). The results of the study also state that multimedia can help overcome weaknesses in classroom learning such as being able to overcome a condition when an object cannot be witnessed in actual circumstances because it cannot be sensed or even if practiced it will be dangerous.

One of the potential science lesson material that is potentially delivered using multimedia is a natural phenomenon, namely lightning. Many people don't know that lightning is also beneficial for life. So far, people only know that lightning is dangerous and many people are victims of lightning strikes. This is due to ignorance of people about static electricity material and its application.

Based on these thoughts, it is necessary to develop multimedia-based scientific literacy on the theme of lightning. This study aims to produce multimedia on the theme of decent lightning so that it can be used in science learning in junior high schools to improve students' scientific literacy.

METHOD

This Research and Development study uses the ADDIE design with the following stages:

1. Analysis. At this stage it is carried out by analyzing the need for the development of multimedia in integrated lightning science learning themes, conducting standard analyzes of content and subject matter, conducting literature studies, and conducting preliminary studies.
2. Design. Design multimedia products based on needs, indicators and

objectives, create storyboards and design scenarios that will be displayed.

3. Development. The multimedia design was then validated by five media experts and material experts. Validation was also carried out by fifteen middle school science teachers in the Cianjur District Education Office using multimedia validation instruments.
4. Implementation. Multimedia results from subsequent validation are used in the learning process to measure students' scientific literacy. The number of class IX students involved in learning is 31 people. The selection of classes is determined by cluster random sampling. The instrument used in the form of multiple choice questions as many as 25 items that are valid questions with a reliability coefficient of 0.76. The twenty-five questions cover the dimensions / domains of context, competence, knowledge, and attitudes as shown in Table 1.

Table 1 Dimenssion of Science Literacy Instruments

Dimenssion of Science Literacy	Number of questions
A. Dimenssion of Science context	
1. Eternal lightning	3
2. Namtang Village Turbin	2
3. Generator van de Graf	5
4. Benefits lightning	3
5. Lightning victim	3
6. Activities during lightning	3
7. Lightning Rod	2
8. Use smartphone when lightning	1
9. Impact of lightning	1
10. Lightning and thunder	1
11. Symptoms of lightning	1
B. Dimenssion of Science Competences	
1. Explain scientific fenomenon	13
2. Designing an experiment	4
3. Interpret and use evidence scientific	8
C. Dimenssion of knowledge	
1. Static electricity	3
2. Electric charge	4
3. Electric conductor	9
4. Coulomb style	2
5. Nitrogen Cycle	2
6. Lghtining	5
D. Dimenssion of Attitude	
1. Interested in science	3
2. Support inquiry scientific	7
3. Awareness and responsibility for the environment	3

5. Multimedia effectiveness to improve scientific literacy of students is determined using one-gruop pretest-posttest design (Fraenkel & Wallen, 2009). The results obtained are then calculated N-gain.
6. Evaluation. The evaluation phase is done by giving a questionnaire to students to describe students' responses to the multimedia produced. The questionnaire results data were processed descriptively quantitatively.

RESULTS AND DISCUSSION

The results of the needs analysis show that students' scientific literacy is still low and multimedia unavailability can be used in lightning theme learning. The use of multimedia is very necessary to support the success of learning processes and outcomes, especially for abstract and dangerous material. The use of multimedia in learning has been done by Aina (2013) which is proven to increase student motivation. Multimedia can also reduce misconceptions and gain meaningful knowledge (Cepni et al, 2010).

Multimedia based on science literacy learning the theme of lightning is multimedia that includes aspects of the science literacy domain, namely the context domain, the domain of science competence, the domain of science knowledge and the domain of science attitude. The material contained in multimedia developed is the process of lightning, the types of lightning, the danger of lightning, anticipation of the dangers of lightning, and the benefits of lightning followed by problem training. In each material delivery begins with the context domain. At the front, the titles of multimedia, targets, multimedia compilers and navigation buttons **mulai**. If you click the start button, a material review article will appear on the theme of lightning, core competencies, basic competencies, and learning objectives.

In the display of Core Competencies, Basic Competencies, and Learning Objectives there are **tombol suara** and **tombol lanjut**, if clicked on the **tombol suara**, a sound will appear according to the written narration. If clicked on the **diklik tombol lanjut,** will show **video** for motivating students and focus students' attention in the learning process. The display on the screen has the **play, stop, pause, fullscreen**, and **lanjut** buttons. **Play** button to **start** the video, **stop** button to close the video, pause button to stop the video, **fullscreen** button to **maximize** the video screen, and **lanjut** button to continue the next show. On the display screen there is a menu of **the process of lightning,** if clicked it will show an **animation** of the occurrence of lightning followed by a **problem**

exercise. In the **animation** display there are **konsep dasar, suara, lanjut**, and **kembali**. If you click on the yellow words, an explanation of the concept will appear, if you click on the basic concept, the science material will appear. if the **suara** is clicked, the narration will appear in the form of audio, if clicked on the **lanjut** button, it will continue to the next animation about the process of lightning, if the button is clicked back the initial animation will appear again. If we will move to the next material, then just click on the **menu** on the **left edge** of the screen.

Design multimedia produced in this study consists of several components, namely in the form of text, images, animation, sound, and video. Multimedia is developed based on the domain of scientific literacy, namely context, content, competence, and scientific attitudes according to the PISA 2015 framework. The context contained in multimedia in the theme of lightning is in the form of everyday life phenomena related to lightning in the form of videos and images. Each material that will be discussed in the lightning multimedia theme always begins with a contextual phenomenon in the form of lightning events, the danger of lightning, images and texts of lightning victims (Figure 1), and the benefits of lightning (Figure 2). Besides being dangerous, lightning is also useful in producing ozone, so it can reduce the depletion of the ozone layer due to global warming.

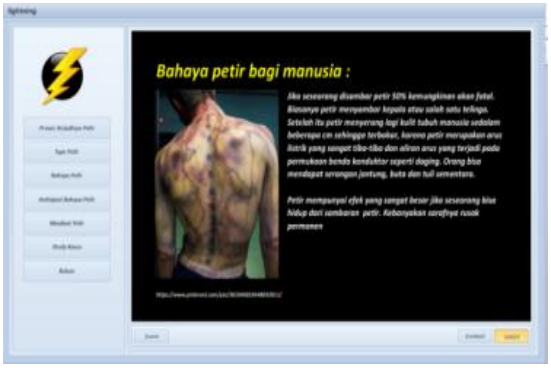

Figure 1. Display of Lightning Danger Context

Figure 2. Display of Lightning Benefit Context

The scope of the content domain in multimedia the theme of lightning is the type of atom, the nature of electric charge, static electricity, sound, light, ozone reaction equations, and nitrogen cycle. Examples of display content domain types of atoms and the nature of electric charges are shown in Figure 3 and Figure 4.

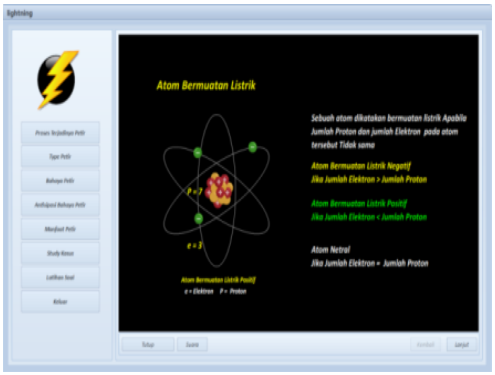

Figure 3. Display of Electrically Charged Atoms

Figure 4. Display of the Nature of Electric Charge.

Figure 3 explains about positive, negative and neutral atoms. Animation about the properties of an electric charge, that is, if a similar charge is brought up there will be an attractive force and if two charges with different charges are brought up there will be a resistive force shown in Figure 4.

The domain of science competence in the 2015 PISA framework has three competencies, namely the competence to explain scientific phenomena, the competence to evaluate and design scientific research, and the competence to interpret scientific data and evidence. These three competencies are also found in lightning multimedia themes as shown in Figure 5, Figure 6, Figure 7, and Figure 8.

Figure 5. Display of Explain Scientific Phenomenon Competence

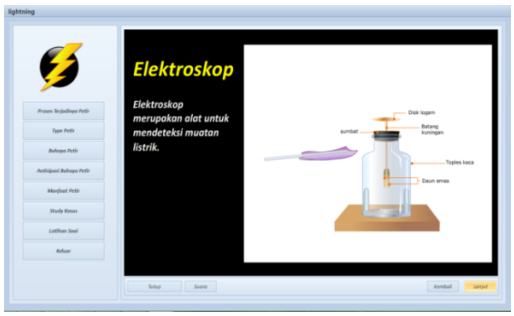

Figure 6. Display of Design Research Competence

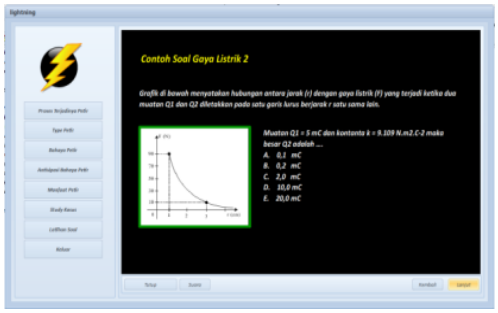

Figure 7. Display of Competence of Data Interpretation

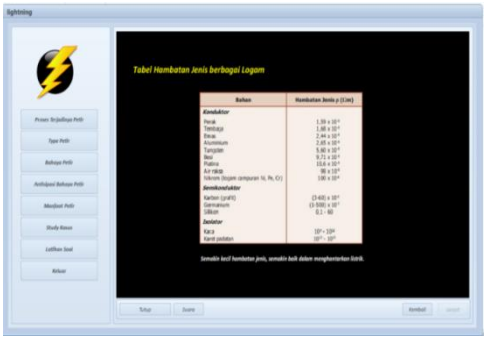

Figure 8. Display of Interpretation Competence of Data and Scientific Evidence

Figure 5 is an animation that explains the phenomenon of the lightning process. This animated show is expected to help students explain the process of lightning starting with the movement of clouds in the air, then rubbing which causes the clouds to become electrically charged differently. As a result of the difference in electrical charge this is what causes the jump of electrons called lightning. While Figure 6 is a show that explains how the electroscope works. If clicked on an image, it will move closer to the head of the charged electroscope so that the leaf of the electroscope will move away if the charge is similar, and move closer together if the electric charge is of a different type. Figures 7 and 8 describe the graph of the relationship between the magnitude of the Coulomb force (F) and the square of the distance between charges (R) and the resistance table of various types of metals. Both of these views require students to be able to interpret data in graphs and tables.

The domain of scientific attitudes in multimedia learning shows that it aims to increase students' alertness when lightning occurs so that they are free from the dangers of lightning, and even further can use lightning energy. Examples of mitigation to avoid the danger of lightning as shown in Figure 9 and Figure 10.

Figure 9. Display of Attitude to Avoiding Science When Lightning Occurs

Figure 10. Display of Science Attitude if when Lightning Occurs in A Car

Figure 9 explains that if there is lightning, we should not connect electronic devices with current sources. Also if there is lightning while in the car. we should keep going by closing all the windshields and not touching the conductor parts of the car (Figure 10). In

addition to the images that have been presented, there are still many other displays that basically to accommodate all the domains contained in scientific literacy.

Some examples of lightning-themed multimedia displays show that this multimedian has been designed with regard to the principles of multimedia development and also the domain of scientific literacy. The principles of multimedia learning development according to Mayer & Moreno in Latif (2015) are (1) there must be a combination of animation and narration, (2) Text presented not too far from animation, (3) related texts / narratives and animations are presented together, (4) avoid words, sounds and videos that are not related to animation, (5) words / texts should be displayed in audio form in explaining animation, and (6) narrative should be presented in the form of conversation not in style formal. In order for multimedia to meet the eligibility requirements for use in learning, multimedia testing or validation is carried out by experts and teachers.

Results of Multimedia Validation

The results of the assessment of multimedia-based scientific literacy of lightning themes by multimedia expert lecturers and material experts are listed in Table 1.

Table 1 shows the average expert assessment of multimedia designed to get an average rating of 87.5%. According to Arikunto (2010), the validation results above 80% include very good categories. So the multimedia learning developed in this study includes a very good category. The acquisition of values in each aspect is relatively the same as the average above 80%. This is due to the presence of multimedia usage instructions clearly explained; the type and color of the letters, as well as the size and layout of the letters of the language used are simple and understandable, the appearance of the background and the colors of the media are attractive, making the quality of multimedia designs very good. Multimedia also has high attractiveness with a combination of text and images, and an attractive composition of display colors. High gain is also found in the compatibility between multimedia content and curriculum. The ease of material structure and the evaluation help students understand the contents of the material about lightning. In addition, the experts also gave an assessment that the multimedia developed had contained the three domains contained in scientific literacy through various image displays, animations, and videos. Some suggestions and input from experts for the perfection of lightning multimedia themes are shown in Table 2.

Table 1. Results of Multimedia Validation by Experts

No	Aspect	Scoring by Validator (%)					Mean (%)	Category
		1	2	3	4	5		
1	Quality of display multimedia learning design	92	86	89	86	83	87,2	Very good
2	Interest of learning multimedia	95	90	90	85	80	88,0	Very good
3	Characteristic of multimedia interactive learning	91	91	87	88	75	86,4	Very good
4	Suitability Multimedia learning with curiculum	95	95	90	90	70	88,0	Very good
5	Domains science literacy in multimedia	89	92	86	89	82	87,6	Very good

Table 2. Suggestions and Feedback on Multimedia Lightning Themes

Validator	Advice and opinion from Validator
Validator 1	1. writing on multimedia is too small 2. It is better if the narration on multimedia is accompanied by audio 3. separate basic concepts
Validator 2	1. At the end of each sub-topic, there should be a problem to reflect on the material presented in multimedia shows
Validator 3	1. We recommend that the video can be full screen 2. In the basic concept of the process of lightning, it is better if the animation of polarizing the electric charge is connected to the earth's magnetic field
Validator 4	1. There should be a narrative that connects the events in the animation 2. add a description for e = electron and p = proton in the basic concept 3. add the original video of the lightning process at the time of the thunder 4. For important concepts, you should use a hyperlink 5. We recommend that the writing does not pass through the image 6. The ozone formation reaction should add the reaction equation 7. There must be clear instructions on the display of facts or myths
Validator 5	1. need to be given a more complete explanation of the basics of electricity (the concept of field and electric potential) 2. The concept of an Isolator and conductor needs to be explained 3. added theory about electromagnetic waves

After the revision was made based on the suggestions and input from the experts, then a feasibility test was carried out by the junior high school science teacher on the multimedia produced. The results of the assessment of multimedia-based science literacy on the theme of lightning carried out by fifteen science teachers were found in Table 3.

Table 3. Results of Multimedia Validation by Teachers

No	Aspect	Mean (%)	Category
1	Multimedia learning goals	92,1	Very good
2	The content of scientific literacy in multimedia	86,3	Very good
3	Easy operation of multimedia	87,1	Very good
4	Multimedia learning potential	87,4	Very good

Table 3 shows the overall average teacher's assessment of multimedia on the theme of lightning by 88.2% with a very good category. Because the results of expert and teacher evaluations show a very good category, the multimedia developed later is implemented in the learning process on the theme of lightning to improve students' scientific literacy.

Science Literacy Students through the use of multimedia on the theme of lightning. Achievement of scientific literacy on the theme of lightning both overall and based on the domain of coverage of scientific literacy is shown in Table 4 in terms of the results of the pretest, posttest, and N-gain results.

Table 4. Achievement of Science Literacy of Students through the Use of Multimedia Themes of Lightning

No	Domain of scientific literacy	Mean		
		Pre-test	Post-test	N-gain (%)
1	The Whole	47,5	78,2	59,3
2	Science competence	41,4	82,3	71,8
3	Science knowledge	48,1	76,9	55,6
4	Scientific attitude	51,6	77,0	51,0

Table 4 shows that overall scientific literacy has an N-gain of 59.3% with sufficient categories. The increase in scientific literacy through the use of multimedia due to multimedia developed has contained the three domains of scientific literacy. These results support the statement of Al-Rsa'i (2013) that learning to use computer technology through a context can build curiosity to find knowledge and improve students' scientific literacy. Lightning-themed multimedia as part of teaching materials is also able to increase science knowledge with sufficient categories. This is in line with the opinion of Glynn and Muth (2009) which states that teaching materials can be used as vehicles to achieve science learning to be more meaningful. The use of computer

technology in learning also helps students build their own knowledge (Cepni, 2009), able to attract students to be actively involved in the learning (Liao & She, 2009). The existence of questions, images, videos, and research planning activities in multimedia also have an impact on improving scientific literacy. Krajcik and Sutherland (2010) suggest that there are instructional activities that can develop scientific literacy, namely: connecting new ideas with initial knowledge, asking meaningful questions, making various representations, giving students the opportunity to use science knowledge, and supporting students to be involved in science learning. The involvement of students in multimedia learning is also in line with the findings of Moradmand et al. (2014) which concluded that multimedia can improve student interaction with content, always complete tasks, and students can learn independently or interact with their friends in pairs or small groups.

The highest achievement of scientific literacy is the science competency domain with N-gain of 71.8 (high category). The acquisition of scientific competencies is obtained from multiple choice questions through the presentation of various scientific contexts namely eternal lightning, challenging village turbines, thunderstorms, the benefits of lightning, the effects of lightning, etc. One example of a problem related to the eternal lightning context.

Eternal Lightning

Have you ever heard of the Catatumbo Lightning? The Catatumbo lightning is a very strange natural phenomenon occuring in the area around Catatumbo river and the Maracaibo Lake in Venezuela. There is a continuous lightning strike with very high intensity in there. According to the Weather website, the Catatumbo-Maracaibo region has 3600 lightning in one hour. This phenomenon means that it occurs every second in 360 nights 365 days (throughout the year) so that it is called eternal lightning.

According to the text above, the phenomenon of lightning in Catatumbo city is estimated to be 3600 times in one hour. How is the process of lightning?

A. Lightning occurs because of the existence of a cloud that has a very large electric charge that causes a jump in the electric charge of other clouds or to the Earth.
B. Lightning occurs because of a cloud that holds very large amounts of water coming from water vapor in the ocean and the land.

C. Lightning occurs because clouds always move due to differences in pressure from one place to another.

D. Lightning occurs because silent clouds are held in the mountain area

The high domain of scientific competence through the use of lightning-themed multimedia due to multimedia has facilitated students to develop scientific competencies through various scientific contexts in the form of text, graphics, and tables (Figure 5, Figure 6, Figure 7, and Figure 8).

The use of various types of representation is able to develop scientific competencies (Krajcik and Sutherland, 2010). Further acquisition of the components of scientific competence based on the results of the pre-test, post-test, and N-gain is shown in Figure 10.

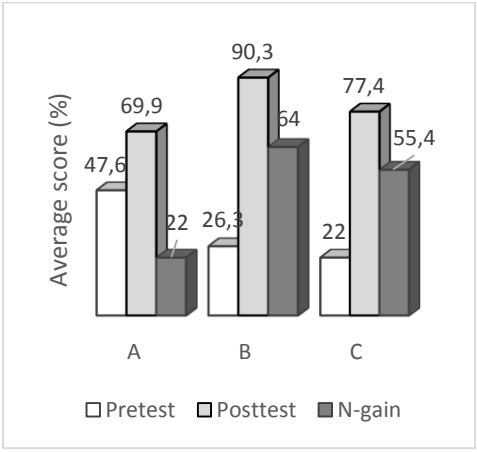

Figure 10. Acquisition of Scope of Science Competence

Information:

A: explain scientific phenomena

B: designing experiments

C: interpret data and support scientific inquiry

Figure 10 show the acquisition of student scores in designing research has the highest gain through the use of multimedia lightning. This is because multimedia developed also provides opportunities for students to engage interactively in planning research. Research planning familiarizes students to search for literature, collect and analyze or interpret data from research results, and communicate the results obtained. This ability is needed by students in studying science holistically. The use of interactive multimedia can also improve scientific literacy even though the increase is still lower than learning that uses lab work in the laboratory (Arisman and Permanasari, 2015).

The use of lightning-themed multimedia is also able to improve students' scientific attitudes even though the increase obtained has enough categories. The scientific attitudes measured in this study include (1) interest in science including curiosity, willingness to continue to increase knowledge, being able to use a number of data or methods, (2) supporting scientific investigations including expressing differences, supporting scientific explanations, and heart- heart draw

conclusions, and (3) awareness and responsibility for the environment. Measuring the attitude of science uses tests in accordance with the existing context. One example of the problem is "can we use mobile phones or cellphones to communicate when there is lightning?" The increase in scientific attitudes obtained in this study is in line with the research of Osman et al (2007) that instilling positive scientific attitudes is important for promoting science learning more effective. The use of lightning-themed multimedia also received a positive response from students. Students stated that multimedia had accommodated all three scientific literacy domains in a particular context (82%), multimedia was also easy to operate (85%), and students felt more motivated (82%) because learning became more fun and interactive.

CONCLUSION

Science literacy-based multimedia learning in the theme of lightning in the form of text, image, animation, dissemination and video is based on the 2015 PISA framework, namely the content domain, competency and science attitude and has a very good category based on the results of due diligence by lecturers and teachers. The results of the implementation of lightning-themed multimedia in science learning in junior high were able to improve students' literacy skills in the medium category.

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