Visual Multimedia Supported Scientific Explanation Text to Improve Elementary School Students' Understanding of The Science Concepts

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Abstract: Low understanding of concepts is one of the classic problems faced in learning science content in elementary schools. This study was conducted to test the use of visual multimedia supported scientific explanation text (VMS-SEText) in learning science content to obtain a depiction of its effectiveness in improving elementary students' conceptual understanding of the direct current circuits. Scientific Explanation text is written in computer format and the visual multimedia used in the text includes phenomenon videos, virtual animation, and dynamic analogies. The method used in this study was pre-experiment with a one-group pretest-posttest design. The research subjects were 80 students from several elementary schools in West Java Province. The data collection instrument used in this research was two types of conceptual understanding test related to the concept of direct current circuits, namely V-Type and F-Type test. The results showed that the use of VMS-SEText could facilitate around 65% of elementary school students to achieve an understanding of the concept of electrical circuits at the sound understanding level. These results indicate that the use of visual multimedia supported scientific explanation text has a moderate effectiveness in improving elementary students' conceptual understanding of direct current circuits.

Keywords: Visual multimedia, Conceptual Understanding, Elementary School Students, Science Concept, Direct Current Circuits.

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INTRODUCTION

Understanding the basic concepts of science is one of the learning outcomes that must be achieved well by elementary school students. Sound understanding of the basic concepts of science will be an important provision when they continue their education to a higher level. A sound understanding of the science concept is also very useful when they want to understand the occurrence of a scientific phenomenon that they encounter in daily life. In the elementary school level curriculum, conceptual understanding is one of the competencies that students must have after participating in learning science. Teachers are required to be able to organize learning that can facilitate the development of conceptual understanding in the minds of students. In the context of face-to-face learning, there have been many science learning models that primary school teachers can use to build an understanding of science concepts in the minds of students. Likewise, for observation activities in the laboratory, various experimental designs that are oriented towards concept building have been developed. However, various learning models and designs for laboratory activities are less useful when there is a Covid-19 pandemic like what is happening now, which requires everyone to stay at home, study, and work from home. Interaction between humans, including teacher and student interactions in learning, is very limited.

One alternative that can be used to overcome this problem is to provide learning materials in the form of text that can be used by students when studying at home. Of course, the required text is interactive. Text is a lingual unit that is provided in writing or orally with a certain organizational structure to express meaning contextually. There are various types of text, including descriptive text, discussion text, explanatory text, exposition text, narrative text, negotiation text, procedural text, and others (KBBI, 2010). One of the texts that can be used to improve students' understanding of the content and various scientific phenomena is the Scientific Explanation Text (SEText).

However, the use of text in which only presents verbal narratives that are only assisted by static figures is seen as not helping much in the process of concepts building related to abstract and microscopic science content. Even though a lot of science content that students have to study has such characteristics. Heat transfer material, electricity, and light are examples of science content that are microscopic and abstract. Pfundt & Duit (1991) stated that the difficulties experienced by students in studying electric and magnetic content were caused by its abstract nature, complexity, and microscopic features.

Other media are needed besides static figure media or photographs that can visualize abstract and microscopic physical phenomena. Students can more easily understand a phenomenon when they have the opportunity to be able to observe the mechanisms or processes that occur in microscopic phenomena, even if they are only in the form of models or illustrations. The development of communication, computation, and information technology has made learning science easier. Some of the features of this technology can be used as a means of visualizing variously invisible abstract or microscopic phenomena into observable phenomena. In the last few decades, there have been many studies that have tried to take advantage of the help of using technology in science learning (Hua & Hong, 2012; Cetin et al, 2001). Likewise, in specific research themes such as the development of teaching materials (text) (Ozkan & Selcuk, 2015; Sahin et al, 2010).

For the process of building an understanding of microscopic and abstract content or phenomena, SEText must be innovated by incorporating dynamic visual media features, such as video phenomena, animation/virtual simulations, and dynamic analogies. When these media features are integrated, SEText is supported by visual multimedia. Furthermore, SEText which is supported by visual multimedia is called Visual Multimedia Supported Scientific Explanation Text (VMM-SEText). This paper describes the process and results of the study related to the implementation of VMS-SEText in science learning about DC circuit content.

METHOD

This study used a pre-experimental method with a one-group pretest-posttest design. With this design, at the time before and after being given treatment (intervention) in the form of the application of VMS-SEText, the subjects were given a pretest and posttest to identify the level of understanding of the direct current electrical circuits (DC circuits) concept of elementary school students. The one group pretest-posttest design is shown in Figure 1.

Pretest	Treatment	Posttest
O	X	O

Figure 1. The research design used in this study

Here O is the conceptual understanding level test and X is the treatment in the form of VMS-SEText implementation. The research subjects were 80 students (49 female and 31 male) from several elementary schools in West Java province.

Data Collection

The data collection instrument used in this study was a test of the level of understanding of the concept of direct current circuits in the form of an essay. There are two types of conceptual understanding level tests used, namely the V-type and the F-type test. The V-type test is a conceptual understanding level test that requires a verbal response while the F-type test is a conceptual understanding level test that requires an image response. The level of conceptual understanding reviewed in this study consists of five levels of conceptual understanding, namely; sound understands, partial understanding, partial understanding with alternative conceptions, alternative conceptions, and no understand (Kurnaz, 2015). To determine the level of conceptual understanding of students based on the test results data was used guidelines as shown in Table 1 (Abraham et al., 1992).

Table 1. Conceptual understanding test scoring rubric for the V-type test (Kurnaz, 2015)

Conceptual understanding level	Score	Criteria
Sound Understanding (SU)	4	The response given contains all the components of the answer that can be accepted scientifically.
Partial Understanding (PU)	3	The response given contains only part of the answer components that can be scientifically accepted from all the expected answer components.
Partial Understanding with Alternative Conception (PU-AC)	2	The response given contains some scientifically acceptable components, but some components of the other answers indicate an alternative conception.
Alternative Conception (AC)	1	The responses were given, all of which cannot be accepted scientifically, contain answers that do not make sense or contradict scientific conceptions.
No, Understand (NU)	0	No response, irrelevant response, or unclear response.

While the scoring of students' answers for the F-type test used a rubric as shown in Table 2 which was adapted from the scoring rubric of the conceptual understanding test used by Abraham et al. (1992) and Arslan (2010).

Table 2. Conceptual understanding test scoring rubric for the F-type test (Abraham et al., 1992) and Arslan, 2010)

Conceptual understanding level	Score	Criteria
Sound Understanding (SU)	4	The depicted image reflects all scientifically acceptable components.
Partial Understanding (PU)	3	The depicted image reflects only a few scientifically acceptable components.
Partial Understanding with Alternative Conception (PU-AC)	2	The picture depicted reflects some scientific components but some parts contain unscientific depictions.
Alternative Conception (AC)	1	The picture depicted reflects the whole section contrary to scientific conceptions.
No, Understand (NU)	0	Blank (not drawing).

The VMS-SEText used as a treatment in this experimental study consisted of three main parts, namely: part 1, the text of presenting scientific phenomena related to the concept; section 2, scientific explanation text, and part 3, concluding text. The VMS-SEText is written in computer format, so it can be supported by dynamic visual media features such as phenomenon videos, virtual animation/simulation, and dynamic analogy videos. Some examples of the dynamic visual multimedia used to support scientific explanation texts are shown in Figure 2

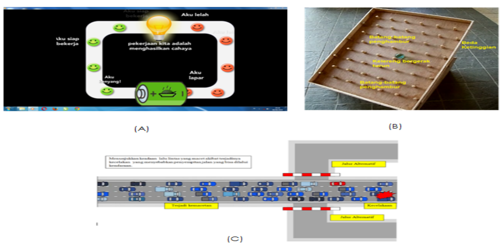

Figure 2. Dynamic visual multimedia used to support section 2 of VMS-SEText related to the concept of DC circuits

RESULTS AND DISCUSSION

Table 3 shows the number of female and male students at each level of conceptual understanding before and after the implementation of the VMS-SEText identified by the V-type test related to the concept of DC circuits.

Table 3. The number of students at each level of understanding the concept of DC Circuits before and after the implementation of the VMS-SEText identified by the V-type test

Before VMS-SEText Implementation					After the VMS-SEText Implementation				
Level of understanding	Number of students		Percent (%)		Level of understanding	Number of students		Percent (%)	
	F	M	F	M		F	M	F	M
SU	2	0	4,1	0	SU	31	20	63,3	64,5
PU	17	13	34,7	42,0	PU	12	8	24,5	25,8
PU-AC	6	4	12,2	12,9	PU-AC	3	2	6,1	6,5

AC	9	5	18,4	16,1	AC	1	0	2,0	0
NU	15	9	30,6	29,0	NU	2	1	4,1	3,2
Total	49	31	100	100	Total	49	31	100	100

Based on the data in Table 3, it can be seen that there has been a change in the level of conceptual understanding of male and female students between before and after the implementation of VMS-SEText. The number of female students who reached the sound understanding level was 63.3%, while the number of male students who reached the sound understanding level was 64.5%. It appears that the percentage of the number of female and male students who reach the level of sound understanding is almost the same when identified by the V-type test. This situation shows that there is no gender bias in achieving the level of sound understanding in the implementation of VMS-SEText related to the concept of DC circuits. Figure 3 shows the pattern of changes in the level of conceptual understanding from before to after the implementation of the VMS-SEText identified by the V-type test.

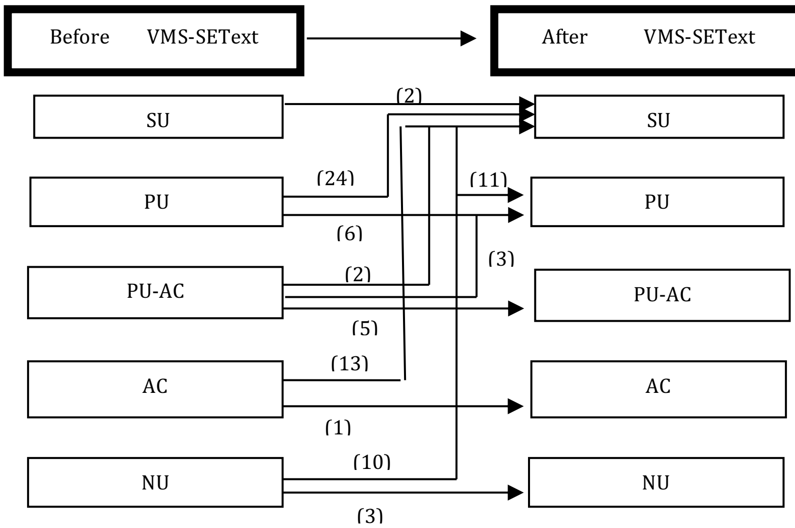

Figure 3. The pattern of changes in the level of conceptual understanding achieved by elementary students when identified by the V-type test

Table 4 shows the number of female and male students at each level of conceptual understanding before and after the implementation of the VMS-SEText identified by the F-type test related to the concept of DC circuits.

Table 4. The number of students at each level of understanding the concept of DC Circuits before and after the implementation of the VMS-SEText identified by the F-type test

Before the VMS-SEText Implementation					After the VMS-SEText Implementation				
Level of understanding	Number of students		Percent (%)		Level of understanding	Number of students		Percent (%)	
	F	M	F	M		F	M	F	M
SU	0	0	0	0	SU	33	20	67,3	64,5
PU	18	15	36,7	48,4	PU	11	7	22,4	22,6
PU-AC	7	4	14,3	12,9	PU-AC	3	2	6,1	6,5
AC	10	4	20,4	12,9	AC	1	1	2,1	3,2
NU	14	8	28,6	25,8	NU	1	1	2,1	3,2
Total	49	31	100	100	Total	49	31	100	100

Based on the data in Table 4, it can be seen that the number of female students who reached the sound understanding level was 67.3% while the number of male students who reached the sound understanding level was 64.5%. It also appears that the percentage of the number of female and male students who reach the level of sound understanding is almost the same when identified by the F-type test. This also shows that there is no gender bias in achieving the level of sound understanding in the implementation of the VMS-SEText related to the concept of DC circuits.

Figure 4 shows the pattern of changes in the level of conceptual understanding from before to after the implementation of the VMS-SEText identified by the F-type test.

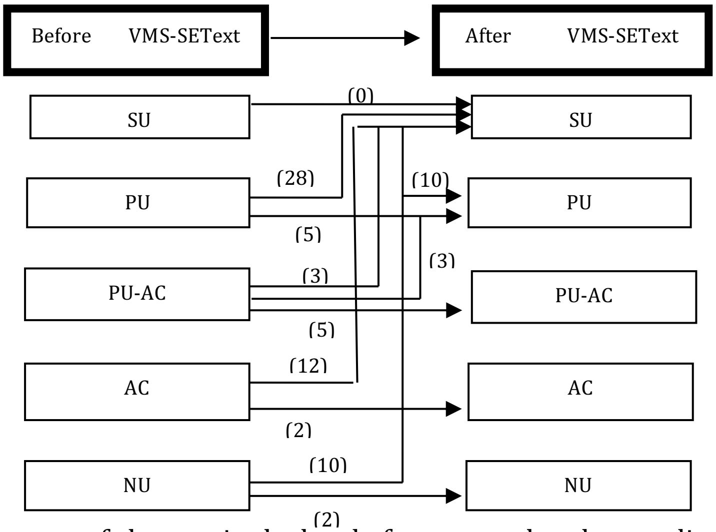

Figure 4. The pattern of changes in the level of conceptual understanding achieved by elementary students when identified by the F-type test

From Table 3 and Table 4, it can be seen that the number of primary school students who attained a sound understanding level was almost the same even though it was identified using two different types of tests, namely the V-type test and the F-type test. This shows that the type of test used does not affect the achievement of the sound understanding level in the implementation of VMS-SEText. This fact is supported by the results of different tests on the number of elementary students who achieved a sound understanding level when identified using the V-type test and the F-type test. The results of different tests using the Mann-Whitney statistical test at the level of confidence ($\alpha = 0.05$) are shown in Table 5.

Table 5. The results of the different test for the number of elementary school students who reach a sound understanding level

Sound understanding level	Mann-Whitney U	Asymp. Sig.	Conclusion
Concept of DC circuits	0.684	0.14	Not significantly different

In Table 5, it appears that the asymp.sig value obtained from the Mann-Whitney statistical test is 0.14 which is greater than the established confidence level ($\alpha = 0.05$). This means that there is no significant difference in the number of elementary school students who achieve a sound understanding level when identified with the level of conceptual understanding test both type-V and type-F. The results of data analysis show that the use of VMS-SEText in learning the concept of DC circuits in elementary schools has moderate effectiveness in facilitating the achievement of a sound understanding level. This is indicated by the percentage of students who reach a sound understanding level of around 63-67%. These results indicate the potential for the use of text as an alternative mode of learning science at the elementary school level during the Covid-19 pandemic, where there are restrictions on direct interaction between teachers and students. Several previous researchers who have examined the effectiveness of using text mode in science learning both to develop conceptual understanding and for remediation of misconceptions include Suhandi et al (2020), Sahin et al (2010), Yumusak et al (2015), and Ozkan & Selcuk (2015).

The good potential of using VMS-SEText in facilitating the achievement of a sound understanding level is due to the presence of visual multimedia presented in part 2 of the VMS-SEText, which is part of the scientific explanation of the natural phenomena being reviewed. The presence of visual multimedia in the form of video phenomena, virtual animation/simulations, and dynamic analogies can help visualize invisible microscopic (abstracts) into observable phenomena so that it will be easier for students to understand. The results of a study related to the use of animation/virtual simulations in science learning conducted by Fallon (2019), Pfefferova (2015) show that Virtual simulation is very useful for visualizing the motion of objects of micro-order or smaller and microscopic phenomena that cannot be observed by students to make it easier for students to understand them. The results of other studies show that when the analogy is used systematically in science learning which contains abstract phenomena, the students' understanding will increase (Dilber & Duzgun, 2008). The results of this study are also in line with the results obtained by Harrison (1993) who reported that several abstract concepts in science such as pressure, electric current, atomic structure, and others can only be taught adequately by using an analogy. Being a conception technique, analogy plays an important role in strengthening students' understanding of concepts in a meaningful way and learning in science education (Aykutlu & Şen, 2011; Gentner & Smith, 2012). The analogy is often used to make abstract scientific concepts more understandable to students (Chiu & Lin, 2005). Because analogy is a way of matching newly learned knowledge with those already in students' long-term memory (Karadoğu, 2007). The use of analogy will improve students' conceptual understanding (Dilber & Duzgun, 2008). For example, it is reported that when analogies are used in teaching scientific concepts such as electricity (Dilber & Duzgun, 2008), pressure (Demirci Güler, 2007; Wong, 1993), and heat conduction and wave properties of light (Harrison & Treagust, 1993), positive changes occur in the achievement of learning outcomes as well as an increased understanding of concepts and improvement of their attitudes towards scientific concepts.

The results of the research on the implementation of VMS-SEText in science learning did not produce gender bias. The implication is that VMS-SEText is suitable to be applied to elementary school students in Indonesia, whose class does not separate female and male students, but rather unites them. Although according to Ali (2019) that in achieving competency in learning outcomes, gender may or may not be influential, but in terms of cognitive learning outcomes, especially regarding conceptions and conceptual understanding, many researchers show that gender does not affect, meaning that both female students and male students have the same opportunity to achieve a scientific conception and sound understanding level. Research conducted by Saleh and Mazlan (2019) shows that gender does not affect conceptual understanding achieved by students. In line with that, the results of Odelphus and Omeodu's (2016) research also show that there is no gender bias in achieving a sound understanding of concepts among students in science learning. Other researchers who also obtained similar results in their research include Ogunleye and Babajide (2011), Ivowi (1983), Inyang and Jegede (1991), Hide and Linn (1988) that gender does not have a significant effect on the achievement of scientific conception and sound understanding level by students.

CONCLUSION

Based on the results of data analysis, it can be concluded that the implementation of VMS-SEText has moderate effectiveness in facilitating the achievement of a sound understanding level related to the concept of DC circuits. There was no significant difference in the number of students who achieved a sound understanding level when identified by a conceptual understanding level test which required a response in the form of a verbal representation (V-type test) or a response in the form of figure representation (F-type test). There is no gender bias in achieving a sound understanding level in the implementation of VMS-SEText.

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