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Application of Immersive Virtual Learning to Understanding Climate Change Concepts and Thinking Process Skills

Asita Al Mufida[1*], Ari Widodo[2], Rini Solihat[2]

[1] Pendidikan IPA, FPMIPA, Universitas Pendidikan Indonesia, Bandung, Indonesia.
[2] Pendidikan Biologi, FPMIPA, Universitas Pendidikan Indonesia, Bandung, Indonesia.

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Abstract: The problem of climate change is currently a problem that worries people around the world. Education is considered one way to solve this problem. However, the material on climate change is challenging to understand because the concepts contained in it are complex and require good thinking skills. Therefore, learning is needed that can facilitate this. Immersive Virtual Learning (IVL) analyzes the results of its application to students' understanding and thinking process abilities. The use of a pre-post control group design involving 59 junior high school students showed student learning outcomes in the class were significantly different from the control class. The understanding of the concept of treatment students is better than the control class students. The same results are also shown in the results of data analysis related to thinking skills in the two classes. It is hoped that there will be further research related to IVL to get better learning outcomes.

Keywords: Immersive Virtual Learning; Climate change; Thinking process skills

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Introduction

Understanding of climate change material is students' knowledge of concepts related to climate change, both related to causes, processes, and impacts. Climate change is considered to be a concept that is quite challenging for students, because it involves many complex system interactions in it (McNeal et al., 2014), and students are required to be able to understand the interrelationships between these systems. Many countries in the world hope for the contribution of education in overcoming these problems (Kolleck, 2016). Understanding of climate change needs to be provided to children as the younger generation whose policies will determine the sustainability of life on earth. Therefore, it is important to equip them with climate change insights so that they can take less harmful actions in the future (Cutter-Mackenzie & Rousell, 2019). However, the results of Kurup et al. (2021) show that students' knowledge of concepts in climate change is still limited. It was further explained that they did not have sufficient knowledge to explain the basics of global warming and climate change. Therefore, it is very important to teach students about climate change, because knowledge about it is the basic thing that students need to have (Kisauzi, et al., 2012).

Students' knowledge of climate change issues is an important thing that needs to be provided to them because how much knowledge they have will determine how much and how well they contribute to preventing climate change (Assan, 2015). Therefore, it is very necessary for teachers to teach climate change material to students. In the process of understanding a concept, a thought process is also required (Knaggs & Schneider, 2012). Thinking is a cognitive process that occurs in the brain (Widodo, 2021). It was further explained that the types of thinking are grouped based on the processes that occur in the brain. Thinking processes can be developed through activities that involve students during the learning process in the classroom. One

* Corresponding Author: asitamufida98@gmail.com

example is the involvement of students in discussion activities (Ratinen et al., 2013). It was further explained that through discussion students would carry out a thought process in order to participate in the discussion activity.

Learning activities seem to be important things that can affect student learning outcomes, both mastery of concepts regarding climate change, as well as their thinking process abilities. The climate change material itself requires student-centered, challenging, and meaningful learning (Monroe et al., 2019), the involvement of local problems as study material is also needed (Ojala, 2016), and student participation in mitigating these problems, as a provision towards a sustainable future (Trott, 2019). Based on these problems, the authors wish to offer Immersive Virtual Learning (IVL) learning which is used to teach climate change material, and then the student learning outcomes will be analyzed after using the IVL learning.

The Covid-19 pandemic has completely changed the way learning is done around the world. The existence of physical distancing makes students and teachers not allowed to meet in one place, so distance learning is created. One of the learning innovations to overcome these obstacles is IVL. The research results of Markowitz et al. (2018) showed that students who had used IVL learning experienced an increase in their knowledge and curiosity about climate change. The same thing was also shown by Parong & Mayer (2021), in which in addition to experiencing an increase in knowledge, students also experienced an increase in their learning motivation. Therefore, in this study, the researcher wanted to see the results of the application of IVL learning on understanding concepts and the thinking process abilities of students.

Method

The design used in this research is the Pretest-Posttest Control Group Design which is one type of research design using the Quasy Experimental Research method. The character of the design is that the selection of participants is not done randomly and each treatment and control group is given a pretest and posttest. This study involved 59 students from two classes in grade 7 of a junior high school in Lamongan Regency, East Java. The selection of participants was carried out based on the results of suggestions and approval from the school. Before learning begins, the pretest is given in the treatment and control classes. After that, the treatment class will conduct learning using the IVL method, in which students carry out several activities, including conducting experiments on the greenhouse effect as an effort to understand students about the process of global warming which is a factor in climate change.

Observing the Virtual Field Trip (VFT) video was also done by the students after the experiment. The video is given to students with the aim that students can find out in real terms the climate change that is happening, both globally and locally in the environment around students. The video contains evidence of climate change in terms of its causes and impacts. Students answer questions based on their observations of the VFT video. In addition, students are also assigned to observe the conditions around their homes related to the causes and impacts of climate change. Webinars with NGOs working in the field of climate care (Greenpeace) are also organized by teachers as a way to understand students about climate change. While listening to the presentation from the speaker, students answer the questions that have been provided on the student worksheet. After the webinar is over, students are welcome to ask questions and discuss with the presenters about the climate change material presented by the presenters. During the learning process, the teacher also uses the lecture method as a complementary activity to explain the material to students and to complete their understanding of the results of carrying out several activities in IVL.

As for the control class, learning is done using group discussions and lectures by the teacher. Most of the time the control class is used by students to discuss problems that occur due to the impact of climate change. Student discussions are guided by the student worksheet that has been provided by the teacher. The lecture method is also used by the teacher to provide a complete explanation of what students are doing and the topic of climate change. After all the series of learning activities have been completed, the teacher then gives a posttest in the treatment class and control class.

Data analysis was carried out after data collection on all series of learning activities in the treatment and control classes was completed. Data analysis regarding the understanding obtained from the pretest and posttest was carried out using the SPSS application. Descriptive analysis was first carried out on the pretest data. Because the results of the pretest showed a significant difference between the treatment and control groups, the next step the author took was to analyze the gain value of each treatment and control class to see how much difference or improvement occurred in the two classes. After the data analysis was completed, a more in-depth discussion was carried out and supported by several references, until finally a conclusion was obtained from the results of this study.

Result and Discussion

Understanding of climate change is students' knowledge of the concepts contained in climate change material, including the causes, processes of occurrence,

and impacts. Learning about climate change material is considered challenging because of the complexity of the concepts contained in it (McNeal et al., 2014). Therefore, this study will describe the results of data analysis on students' conceptual understanding of climate change and their ability to think after applying Immersive Virtual Learning (IVL) in their learning. After the descriptive analysis was carried out, overall it showed that the learning outcomes of students in the treatment class were significantly different from those in the control class (Table 1).

Table 1. Data Analysis of Concept Understanding Test Results

Data Type		Pretest		Gain	
		Exp	Control	Experiment	Control
Total Students		29	30	29	30
Average		62.07	50.67	15.52	09.17
Standard Deviation		11.54	7.28	8.49	3.96
Normality Test	Sig.	0,019	0.001	0.002	0.000
	Inter.	Abnormal		Abnormal	
Homogeneity Test	Sig.	0.001		0,000	
	Inter.	Inhomogeneous		Inhomogenous	
Mann Withney Test	Sig.	0.000		0.000	
	Inter.	Significantly Different		Significantly Different	

In Table 1 it is shown that student learning outcomes in the treatment class are better than students in the control class. Both classes experienced an increase in learning outcomes, but the increase in the treatment class was greater than in the control class. Students in the control class, experienced an increase in some concepts and thinking process abilities and experienced a decrease in others. The increase that is not so big indicates that students' understanding of climate change is still limited. The same thing was also expressed by Kurup et al. (2021) in their research which shows that there are still many students who have limited knowledge about the concepts of climate change.

The greater improvement that occurred in the treatment class showed that IVL learning had a positive influence on student learning outcomes. This is supported by Petersen et al. (2020) on the results of their previous research. IVL learning can improve learning outcomes because it is considered to be able to guide students in learning concepts efficiently (Rao & Saha, 2019). In addition, IVL can also provide new knowledge to students in the form of visual information (Huang et al., 2020). IVL learning is designed in such a way as to create interesting, participatory, and collaborative learning for students (Spector et al., 2014), and it is further explained that through IVL, teachers can show a process that lasts a long time to be shorter so that the process that is taking place is shorter. years can be simulated in seconds or minutes. Therefore, based on these advantages, IVL is suitable to be used to study climate change, which takes a long time.

The opposite result is shown in the control class. This indicates that conventional learning applied in the control class is less effective in teaching climate change material. One of the ineffectiveness is that group work activities are less meaningful. It is said that because students who are involved in group work do not perform their duties optimally what is produced is not as expected, according to Sachmpazidi et al. (2021), success in group work is determined by how well each member of the group performs. The concentration of students' learning that is divided is the cause of the students' not working optimally in groups. This is caused by the disintegration of students' concentration on cellphones and games. As a result, it will affect students' interest in learning (Meutia et al., 2020). In addition, another factor is due to obstacles in learning, where these obstacles can affect the process and learning outcomes (Handayani & Jumadi, 2021).

In more detail, the data is presented in Table 2 regarding students' understanding of climate change concepts that have increased or decreased, both in the treatment class and the control class. The concepts include 1 (Composition of the atmosphere, weather, climate, and climate change), concept 2 (Anthropogenic sources that contribute to climate change), concept 3 (Impact of climate change on ecosystems), and concept 4 (Solutions for climate change). climate). The sign (+) indicates that the student's score has increased, while the sign (-) indicates that the student's score has decreased from pretest to posttest. The following is Table 2 which presents the results of the analysis of students' conceptual mastery of climate change material:

Table 2. Average Improvement for Each Concept

Draft	Treatment Class Score		Gain	Control Class Score		Gain
	Pretest	Posttest		Pretest	Posttest	
1	39,70	43,10	+ 3,40	48,80	37,50	- 11,30
2	25,30	32,50	+ 7,20	19,70	17,50	- 2,20
3	31,30	42,00	+ 10,70	28,60	31,40	+ 2,80
4	30,00	30,30	+ 0,30	17,30	22,70	+ 5,40

Based on the data in Table 2, it can be seen that students in the treatment class experienced an increase

in conceptual understanding of all concepts in climate change. This happened after students learned to use IVL. IVL learning is indicated to have an influence on increasing students' conceptual understanding due to the many real examples presented in the learning. Through the provision of information about the problems that occur in the environment around students, students can make learning meaningful and deep, so as to improve student learning outcomes (Zimmerman & Weible, 2017). In addition, in IVL learning there are also environmental observation activities, both directly and virtually. According to the results of previous research, it was shown that real experience gained through observation could improve students' cognitive abilities (Lu, 2017). Therefore, the observation activities in IVL provide additional insight to students in the treatment class, so that their conceptual understanding becomes better than before.

It was different with the students in the control class. students in the class experienced a decrease in conceptual understanding of 2 concepts of climate change. The biggest decline is precisely in the understanding of the basic concepts of climate change, namely the concepts of climate, weather, and the composition of the atmosphere. According to Syar (2017), his research shows that the concept of weather and atmospheric composition is a concept that is difficult to understand. Meanwhile, according to Umam (2012), the reduced ability of students to understand concepts is a result of the lack of students' ability to think, because in the process of understanding concepts, thinking process skills are needed. This is supported by facts in the classroom which show that the majority of students in the control class do not take the learning seriously. Their lack of seriousness in following the lesson makes them difficult to think and difficult to concentrate. To be able to master the concept requires seriousness in learning (Syar, 2017). Another decline occurred in the concept of anthropogenic sources causing climate change. Previous research explained that this can happen because there is a possibility that students feel confused between the causes and effects or consequences of climate change. After all, they only focus on rising temperatures (Varela et al., 2020).

As explained earlier, in the process of understanding the concept, a thought process is also required. In Table 1 it is shown that the thinking ability (such as the grouping done by Bloom) of students in the treatment class has increased in all thinking processes, including the ability to remember (C1), understand (C2), apply (C3), analyze (C4), and evaluate (C5). The students in the control class experienced a decrease in their ability to think, remember (C1), and analyze (C4). Based on these general results, it can be seen that IVL learning has a positive effect on the development of students' thinking process abilities.

Table 3. Average Improvement of Thinking Ability

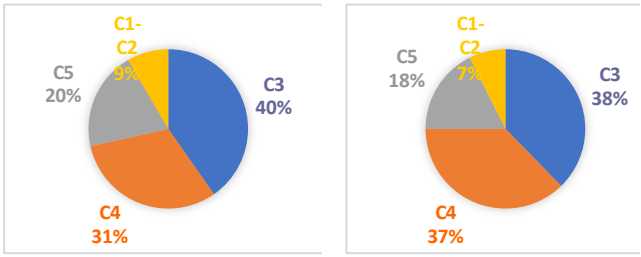
Thinking Type	Treatment Class Score		Score Change	Control Class Score		Score Change
	Pre	Post		Pre	Post	
C1	43,10	44,80	+ 1,70	48,30	41,70	- 6,60
C2	37,40	43,90	+ 6,50	36,30	39,10	+ 2,80
C3	27,00	30,40	+ 3,40	13,10	22,50	+ 9,40
C4	29,30	42,10	+ 12,80	24,60	17,70	- 6,90
C5	19,00	25,90	+ 6,90	07,50	12,50	+ 5,00

Thinking is a cognitive process that occurs in the brain (Widodo, 2021). If you want to develop thinking skills, then the habit of making cognitive processes in the brain must be done. It is proven that through IVL learning, students' thinking skills get better. This is because during learning with IVL students are invited to do many activities that can indirectly hone their thinking skills. The ability to think "analyze" becomes the thinking ability with the largest increase in the treatment class. This happens because during IVL learning students are trained to analyze various problems that occur related to climate change issues, and students are asked to propose a solution to the problem. The results of previous studies show that student-centered learning has a positive influence on student learning outcomes (Xiong et al., 2015). This happens because student-centered learning, such as IVL, can facilitate students to explore a lot of information, practice collaboration and discussion skills, to be able to provide solutions to solve problems.

In contrast to the treatment class. In the control class, the lowest decline occurred in analytical thinking ability (C4). This is because the control class still uses conventional learning and meaningless discussions. It is said that the discussion is not meaningful because even though students gather in groups, there is no discussion, argument, or discussion of joint problems like discussions in general. Whereas discussion activities are one way to train students' complex thinking skills (Mukarromah et al., 2020). In addition, students in the control class are quite passive, it is very rare to find students asking the teacher about the topic being discussed or the material. being studied. They seem to work individually and only rely on the internet. The opposite results are shown in the research of Setianingsih et al. (2018) which shows that in the discussion process students do many things, including identifying, analyzing, finding solutions to problems, as well as applying the concepts obtained to new problems, so that complex thinking skills such as analytical thinking can be trained. Unfortunately, some of these things were not found in the discussion process in the control class.

In Figure 1, data are presented that implicitly indicate that students' complex thinking skills still need to be retrained. It is evident from the data on the graph that describes the proportion of students' errors in

answering the question, indicating that the most errors of students in the treatment and control classes were questions in the categories C3 (applying) and C5 (evaluating).



A. Experimental class B. Control class

Figure 1. The proportion of the number of posttest errors

According to Di et al. (2019), students' complex thinking process skills still need to be honed again. One way is to involve technology in learning because technology-based learning tools can improve complex thinking skills (Pletz & Zinn, 2020). It is evident from IVL learning that involves technology and student learning outcomes are better than before. However, the technology used in immersive learning is not something that can improve learning outcomes in general, but only applies to certain areas (Beck, 2019) and if it can be applied effectively (De Back et al., 2021). Therefore, it is necessary to make significant improvements to the IVL method to obtain better results in the future, resulting in much better benefits.

Conclusion

Based on the results of the analysis of the research data, it can be concluded that students' understanding of climate change has increased. Changes in understanding that occurred in students in the treatment class were significantly different from changes in students' understanding in the control class. Students in the treatment class experienced an increase in better understanding than students in the control class. Although there was an increase in understanding in both classes, both of them experienced a not-so-great increase, so it can be said that students' understanding of climate change still needs to be improved again. The results of the analysis of students' conceptual mastery showed that students in the treatment class experienced an increase in understanding of all concepts on climate change material. Meanwhile, students in the treatment class experienced an increase and decrease. The same results are also found in students' thinking process abilities. Students in the treatment class experienced an increase in several kinds of thinking skills categorized by Bloom. However, students in the control class experienced an increase and a decrease in their thinking processability.

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