Vol 11 No 1 2025 DOI : 10.24036/jppf.v11i1.7 Page : 01-12
JURNAL PENELITIAN PEMBELAJARAN FISIKA (JPPF)
Journal of Physics Learning Research
ISSN 2252-3014 (Print) | ISSN 2746-8445 (Electronic)

The Effect of Using Interactive Multimedia Based on Cognitive Conflict-Based Learning on Global Warming Material on Student Retention

Muhdia Nahdhah[1], Fatni Mufit[2*]

[1,2] Departmen of Physics Education, Universitas Negeri Padang, Padang, Indonesia.

ARTICLE INFORMATION

Received : 2025-03-17
Revised : 2025-02-25
Accepted : 2025-03-26

Correspondence
Email : fatni_mufit@fmipa.unp.ac.id
Phone : N/A

KEYWORDS :

Interactive Multimedia, Cognitive Conflict, Global Warming, Retention

ABSTRACT

The aim of learning physics is that students understand the learning concept before moving on to the next material. Physics learning is conditional in that concepts are mutually continuous so students must understand the material before continuing to the next material. In fact, in the field, students still experience conceptual misunderstandings in global warming material. The way out to overcome this is the use of interactive multimedia based on cognitive conflict to correct students' misconceptions and make them last longer in students' memories. The aim of this research is to see the effect of using interactive multimedia based on cognitive conflict on student retention. This research was conducted using a quasi-experimental design or quasi-experimental method. This research design uses a nonequivalent control group design, with two sample classes, namely the experimental class and the control class, each consisting of 28 students. The research instrument was 25 concept test questions about global warming material, with data collection through pretest, posttest and retest. The hypothesis analysis technique uses the Mann-Whitney test. The results indicate that students in the experimental class had higher retention compared to those in the control class. Although both groups experienced a decline in memory, the decrease was less significant in the experimental class. The hypothesis test yielded a result of 0.11 at a 0.05 significance level, confirming a significant impact of interactive multimedia based on cognitive conflict on student retention in the global warming topic. Therefore, in can be conclude that this learning approach effectively enhances student retention.

INTRODUCTION

Twenty first century learning must lead to the achievement of learning objectives. The learning objectives are that students can understand the concepts well. To achieve twenty first century learning objectives, technology integration in learning is required. This is also included in physics learning, which is conditional learning, namely students need to understand the concept of the material before they can continue on the next material because

the material is interconnected so that if they do not understand the concept students will have difficulty understanding learning for the next. There are three levels of concept understanding, namely: understanding the concept, wrong concept, and not understanding the concept or misconception (Mufit et al., 2018).

To achieve learning objectives through education. Learning can be more effective with better communication tools, namely teaching materials. Teaching materials can be defined as all forms of materials that are systematically arranged to enable students to learn independently and are designed in accordance with the applicable curriculum (Magdalena et al., 2020; Waraulia, 2020). For teachers, teaching materials play a role in directing students during learning activities. For students, teaching materials as a learning resource and help students understand learning materials (Hamid & Alberida, 2021). Therefore, the selection of media must be absolutely right so that the desired learning objectives can be achieved easily. Which is where the utilization of this learning media, will support the effectiveness, efficiency and also attractiveness in learning. therefore, teachers need to do careful planning when designing learning in the classroom. And realize the importance of learning media in the teaching and learning process. Teachers should also understand that without learning media. Learning will be monotonous and also the learning process will not learn effectively and students are easily bored (Wulandari et al., 2023).

Referring to the integration of technology in learning, one of the teaching materials that can be used is interactive multimedia. Interactive multimedia has become an increasingly popular learning tool in modern education. It is able to present learning materials comprehensively through a combination of visual, audio and kinesthetic elements, thus accommodating various learning styles of students. With its ability to combine text, images, animation, sound and video in one interactive platform, interactive multimedia offers a richer and more immersive learning experience than conventional learning methods (Djatmika & Praherdhiono, 2024). With interactive multimedia students can learn independently and engage in interaction with the teacher. Students will get a better understanding because the learning process is done directly by students.

Apart from using appropriate teaching materials, the learning model applied together with the use of teaching materials is also equally important in achieving good student understanding of concepts. A learning model is a series or arrangement that has been planned which is used as a guide in planning classroom learning (Redhana, 2019). A variety of media and learning model are available, but they have not been used optimally, which in turn hinders students' interest and understanding in learning physics (Kartika et al., 2022). An effective learning model can make it easier for students to understand learning (Sarnoto et al., 2023). Teachers and students have the ability to grasp concepts. Learning materials are interconnected, allowing students to comprehend other concepts more easily if they have a solid understanding of one concept (Sari et al., 2024).

A Cognitive conflict strategy is one of the strategies that can improve concept understanding so that it can overcome students' misconceptions (Hasanah et al., 2020). This model helps students recognize and resolve their misconceptions by challenging their existing knowledge, ultimately guiding them toward accurate scientific concepts. There are four syntaxes of cognitive conflict-based learning model, namely (1) activation of preconceptions and misconceptions, (2) Presentation of cognitive conflict, (3) Discovery of concepts and equations, (4) reflection (Mufit, 2018). In physics learning, one of the learning materials that often occur conceptual error is global warming material. The importance of a student's knowledge and learning experience where the learning material is directly related to the state of nature or the surrounding environment so that students are involved in efforts to preserve nature, especially the environment around where they live (Akwantin et al., 2022).

In one of the studies conducted by Pramono at Simpang Semambangan High School on analyzing the implementation of learning on global warming material, it was found that the implementation of learning on global warming material was still dominated by learning directly explained by the teacher while delivery through IT-based teaching materials was still relatively low. This can cause the learning process to be monotonous for students, make students less active, and not interested in participating in learning well so that it can cause students not to understand the concept or the occurrence of concept errors in students' memories. Conceptual errors (misconceptions) can hinder the process of receiving new knowledge that is trying to be built through learning. If misconceptions are not corrected from the start, they will persist and hinder the next learning process (Pramono & Mufit, 2022).

After conducting an initial study in the form of a pretest on global warming material in Class X, Phase E, at SMAN 3 Painan, the results indicated that students still held misconceptions about the topic. This was evident from the posttest scores, which showed that the majority of students scored below the school's minimum competency criteria (KKM). Further analysis, based on two articles examining students' conceptual understanding of global warming, revealed that the most frequent misconceptions occurred in specific subtopics. These included global warming itself, ozone layer depletion, the greenhouse effect, and acid rain (Krisna et al., 2021).

The way out to overcome the problems contained in global warming material in learning is by using cognitive conflict-based interactive multimedia which is prepared using the syntax of the cognitive conflict-based learning model by (Pramono & Mufit, 2022). The cognitive conflict learning model is an instructional approach aimed at resolving the gap between students' initial understanding, shaped by their environment, and accurate scientific knowledge. The process involves activating prior beliefs and misconceptions, introducing cognitive conflict, guiding the discovery of new concepts, and encouraging reflection (Mufit, 2018). The cognitive conflict learning model is designed to reveal students' initial knowledge before learning begins, identify whether there are errors, and this model presents phenomena that occur around them which can cause students to have new ideas and their own thoughts about them.

The ability to receive, store and repeat information is referred to as retention. The ability to store data for a few seconds (short-term retention), for a few seconds when used (active-acting retention), over a longer period of time (long-term retention). Complex processes and the application of various strategies to help students remember information are part of retention. There is an influence of models and media on short-term and long-term retention learning, according to research conducted by (Agustianda et al., 2024; Mamonto, 2024). Learning models that involve students in finding information about learning are more imprinted on students' memories (retention) than just teachers who deliver learning materials.

Learning that is able to actively involve students and can improve retention requires the right learning model and teaching materials. Strong retention makes the information received by students will be stored in memory and will make it easier for brain cells to connect with each other. Students who have weak retention can adversely affect the value of learning outcomes. Material retention improves when students have the opportunity to actively explore concepts. This is supported by Magnesen's research, which suggests that we remember 10% of what we read, 20% of what we hear, 30% of what we see, 50% of what we hear and see, 70% of what we say, and 90% of what we both say and do (Hernacki, 2010).

To address the issues described, a proposed solution is the implementation of interactive multimedia based on the cognitive conflict learning model. This approach is designed to help students identify and correct their misconceptions by actively engaging them in the learning process through thought-provoking scenarios and interactive elements. By presenting conflicting information that challenges students' existing beliefs, this model encourages

critical thinking and deeper conceptual understanding. Additionally, the use of interactive multimedia enhances student engagement and motivation, making the learning experience more dynamic and effective. Through this method, not only can misconceptions be corrected, but students are also more likely to retain the newly acquired knowledge in their long-term memory. As a result, they can develop a more accurate and comprehensive understanding of global warming and its related subtopics, ultimately improving their overall academic performance.

METHODS

The research method used in this research is the Quasi Experimental Design method (quasi experiment). Quasi experimental design is used because in reality it is difficult to get a control group used for research. The research design used was nonequivalent control group design. At the beginning of the learning activity, an initial test (pre-test) was conducted to measure the initial ability of students, then learning treatment using interactive multimedia was carried out. After that, the final test (post-test) is given at the end of the learning process to determine changes in student learning outcomes after the learning is over. Then a retest was conducted after three months of the post-test. The purpose is to measure students' ability to retain memories of the subject matter that has been given in their brain memory.

The research design using nonequivalent implementation requires two groups, namely: The experimental group, which is a group of students who are given treatment or in other words, the learning process uses interactive multimedia. Learning is done in the classroom with students using laptops as a learning tool. On the laptop, a learning multimedia application has been installed with its previous use simulated through the projector screen before students start using it independently. The multimedia used is a cognitive conflict-based interactive multimedia used has gone through a process of validation from experts and revision so that it has been considered suitable for use in this study. Control group, which is a group of students who are used as a benchmark by using learning methods that only use power point teaching materials and models used by teachers at school. With this research, it can be seen the effectiveness of interactive multimedia on student retention compared to classes that use cooperative learning models with teaching materials used by teachers at school, namely printed books for class X physics learning.

Research Procedures

The stages used in this research are as follows Preparatory Stage that include Determine the place and schedule of research, obtaining a research permit from the West Sumatra provincial education office, Determining the research population and sample, Determining the experimental class and control class, preparing learning tools, and making a lattice of research instruments. Implementation Stage include The research was conducted with a population of students of class X Phase E SMA Negeri 3 Painan with research sampling, The research was conducted by giving a different treatment between the experimental class and the control class, where the experimental class was given treatment in the form of using cognitive conflict-based interactive multimedia while the control class used the model and teaching materials used by teachers at school, The research was conducted to see the effect of the use of interactive multimedia based on cognitive conflict on student retention, and The effect is seen by doing posttest and retest on both classes. Completion stage include collecting research data in the form of posttests and retests, processing data using the SPSS version 29.0.0 application, analyzing research data from both sample classes, drawing conclusions about the effect on student retention, and compile a research report.

Population

The source of research data is obtained from the set of research subjects which all have certain characteristics or are called populations (Hardani, Auliya, N. H., Andriani, N., Fardani, R. A., Ustiawaty, J.,Utami, E. F., Sukmana, D. J., 2020). This study with a population of 112 students from all classes X Phase E even semester of the 2023/2024 academic year SMA Negeri 3 Painan consisting of classes X E 1 - X E 4.

Sample

After knowing the population, the next step is to determine the research sample. Taking part of the population members (samples) is done through certain techniques. The technique in this study uses purposive sampling or not randomly selected. This method is used because the sample selection cannot change the previously formed class, besides that the selection is also not done randomly for individuals (Hardani, Auliya, N. H., Andriani, N., Fardani, R. A., Ustiawaty, J.,Utami, E. F., Sukmana, D. J., 2020). This study selected two sample groups from four groups of X Phase E classes at SMA Negeri 3 Painan with a total of 28 students as the experimental class and 28 students as the control class. The following are the steps taken in sampling: Collecting the results of students' initial knowledge obtained through pretests conducted in all population classes, take 2 classes that have the same pretest score and get 2 sample classes, and conduct a normality test to see whether the two sample classes are normally distributed or not. Based on the results of the normality test using the SPSS version 29.0.0 application. in both sample classes, both are <0.001 with normality of 0.005 so that data is not normal.

Conduct a homogeneity test to see whether the sample class is homogeneous or not. Based on the results of the homogeneity test using the SPSS version 29.0.0 application. the data of the two sample classes obtained a homogeneity value> 0.05, namely 0.946 so that the data is homogeneous. Conducting an equality test of two averages. This test is conducted to see whether the two sample classes have the same initial ability or not. The test performed is the Mann-Whitney test because the data is not normally distributed and homogeneous.

After conducting the Mann-Whitney test on the two sample classes, the value> 0.05 is 0.784, which means that the two sample classes have the same initial ability before being given treatment. Determining the experimental class and control class. The class used as the experimental class is a class where all students have laptops for the purpose of using interactive multimedia more effectively.

Data Collection Technique

Data collection techniques using written tests intended to determine the final results of the treatment using interactive multimedia in learning activities, consisting of post-test and retest.

Table 1. Data Collection Technique

Data Source	Data Type	Data Collection Technique	Research Instruments
Student	Student learning outcomes	*Posttest* and *Retest*	Question items on the independent curriculum question model

(Ningsih et al., 2019)

Research Instruments

Research instruments are measuring instruments used to measure in the context of data collection. To obtain research data, researchers use test instruments. A test is a series of questions or exercises and other tools used to measure skills, intelligence knowledge, abilities or talents possessed by individuals or groups. In this study, the test model used is the

independent curriculum question model, which contains questions by presenting a stimulus then students are asked to check the correct statement, or check the correct or incorrect statement, pair the statement with the correct answer, answer questions with a choice of several options a, b, c, d and e, and answer short essay questions according to the stimulus given as many as 25 questions. The questions used in the test were taken from the Physics Science learning print book for SMA/MA class X.

Data Analysis Technique

After the experiment was carried out, data was obtained in the form of posttest and retest scores. Then the data is used to get the retention value of the global warming material of SMA class X Phase E. To get the retention value, the following formula is used:

$$R = \frac{Retest}{Post\ test} \times 100\%$$

(Ningsih et al., 2019)

The retention data obtained was then subjected to prerequisite testing and mean difference hypothesis testing. Before hypothesis testing is carried out, testing of the data obtained is carried out, with normality test and homogeneity test. The normality test used is the Saphiro Wilk test. This test is carried out to see whether the data that has been obtained is normally distributed or not. This test is carried out to determine whether the data is parametric or non-parametric. The normality test was carried out with the SPSS version 29.0.0 application. The significant level used in the normality test is 0.05. Based on the normality test using the SPSS version 29.0.0 application, it was found that the significance value of the experimental class was 0.029 and the control class was 0.902, meaning that the retention data in the experimental class was not normally distributed, while the control class retention data was normally distributed. Homogeneity test is conducted to determine whether the two samples are homogeneous or heterogeneous. The homogeneity test used in this study is the Levene test using the SPSS version 29.0.0 application. The significant level used is> 0.05. After the data is tested, the homogeneity value is <0.001, which means the data is not homogeneous. The Mann Whitney mean difference test was used because the data obtained by one of them was not normally distributed and both data were not homogeneous. The test was conducted using the SPSS version 29.0.0 application. The significance level is <0.05.

RESULTS AND DISCUSSION

Results

On Table 1, the average posttest score of the experimental class was higher than that of the control class. In the retest, both classes exhibited a decline in memory; however, the decrease was less pronounced in the experimental class. Consequently, the retention value of the experimental class was significantly higher than that of the control class.

Table 2. Data on Posttest, Retest, and Retention Results

Data type	Posttest		Retest		Retention	
Class	Experiment	Control	Experiment	Control	Experiment	Control
N	28	28	28	28	28	28
Highest score	96.00	96.00	96.00	88.00	116.05	101.69
Lowest score	70.00	59.00	72.00	60.00	90.11	87.78
Mean	88.14	79.85	87.60	75.21	99.76	94.33

Standard deviation	6.32	8.43	5.07	720	7.79	3.23

Based on the data in Table 2, the average posttest of the experimental class is 88.14, higher than the average of the control class which is 79.85. With the highest score in the experimental class and control class both 96.00 and the lowest score of 70.00 in the experimental class and 59.00 in the control class. It can be seen that the retest value of the experimental class has decreased but not significantly only about 0.54 to 87.60. While the average retest value of the control class experienced a greater decline than the experimental class by 4.64 to 75.21. With the highest score in the experimental class still at 96.00 while the control class was 88.00. The lowest score in both classes has increased, 72.00 in the experimental class and 60.00 in the control class. In Table 5 the average value of retention in the experimental class is 5.43% higher than the control class. Where the experimental class is 99.76% and the control class is 94.33%. However, in the experimental class the highest value of retention reached 116.05%, while in the control class the highest value was 101.69%. The lowest value between the experimental class was 2.98% higher than the control class, which was 90.76% and the experimental class was 87.78%.

Before conducting hypothesis testing, the retention value data underwent both a normality test and a homogeneity test to ensure the validity of the analysis. These tests were performed using the SPSS version 29.0.0 software. The normality test was conducted to determine whether the collected data followed a normal distribution, which is a crucial assumption for many statistical analyses. Specifically, the Shapiro-Wilk normality test was employed to assess the distribution of the data, as it is well-suited for small to moderate sample sizes and provides a reliable measure of normality. Ensuring that the data met these assumptions was essential for proceeding with accurate and meaningful hypothesis testing.

Table 3. Saphiro Wilk Normality Test

Class	Shapiro-Wilk Statistic	df	Sig.
Experiment Class	.917	28	.029
Control Class	.982	28	.902

Based on the decision-making guidelines for the Shapiro-Wilk normality test, if the significance (Sig.) value is greater than 0.05, the data is considered to be normally distributed. Conversely, if the Sig. value is less than 0.05, the data is not normally distributed. Referring to Table 6, the obtained Sig. value is 0.029, which is less than 0.05. Therefore, it can be concluded that the data does not follow a normal distribution. This result indicates that further statistical analysis may require non-parametric methods to ensure the validity of the findings.

Furthermore, a homogeneity test was conducted to determine whether the data exhibited uniform variance across groups. To assess this, Levene's test was employed, as it is widely used to evaluate the assumption of homogeneity of variances in statistical analyses. Ensuring homogeneity is crucial, as it affects the validity of comparative statistical tests. If the data meets the homogeneity assumption, parametric tests can be appropriately applied; otherwise, alternative non-parametric methods may be necessary for accurate analysis.

Table 4. Levene's Homogeneity Test

Indicator	Levene Statistic	df 1	df2	Sig.
Based on Mean	17.702	1	54	<,001
Based on Median	17.617	1	54	<,001
Based on Median and with adjusted df	17.617	1	37.519	<,001

Based on trimmed mean	17.602	1	54	<,001

The decision-making guidelines for Levene's homogeneity test state that if the significance (Sig.) value is greater than 0.05, the data group variances are considered the same (homogeneous). Conversely, if the Sig. value is less than 0.05, the data group variances are not the same (heterogeneous). Referring to Table 7, the obtained Sig. value is less than 0.001, which is significantly lower than 0.05. Therefore, it can be concluded that the data is not homogeneous. This result suggests that assumptions of equal variance are violated, and as a consequence, alternative statistical approaches, such as non-parametric tests or adjusted parametric methods, may be required for further analysis.

After conducting the normality and homogeneity tests, the Mann-Whitney U test was selected for the mean difference hypothesis test. This choice was made because the data obtained either did not follow a normal distribution, or both datasets were found to be inhomogeneous. The Mann-Whitney U test is a nonparametric statistical method used to assess whether there is a significant difference between two independent groups. This test is particularly useful when the assumptions for parametric tests, such as normality and homogeneity of variance, are not met. By using the Mann-Whitney U test, the analysis ensures that valid conclusions can be drawn despite the violation of these assumptions.

Table 5. Mann-Whitney Mean Difference Hypothesis Test

Indicator	Retention
Mann-Whitney U	236.000
Wilcoxon W	642.000
Z	-2.557
Asymp. Sig. (2-tailed)	.011

Table 8 presents the results of the Mann-Whitney U mean difference hypothesis test conducted to assess the impact of interactive multimedia based on cognitive conflict on student retention. The Mann-Whitney U value is 236.000, and the Wilcoxon W value is 642.000, both of which are used in the calculation of the test statistic. The Z value is -2.557, indicating the direction and strength of the difference between the groups. Most importantly, the Asymp. Sig. (2-tailed) value is 0.011, which is less than the significance level of 0.05. This indicates that there is a statistically significant difference between the groups, suggesting that the use of interactive multimedia based on cognitive conflict has a positive effect on student retention. Therefore, the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted, confirming the effectiveness of the cognitive conflict-based multimedia approach in improving retention.

Discussion

The results of the mean difference test indicate a significant difference between the experimental and control classes. This difference is likely due to the distinct treatments applied to the two groups. The experimental class was taught using interactive multimedia based on the cognitive conflict learning model, while the control class learned solely with printed books and the cooperative learning model.

In the control class that used the cooperative learning model, it was carried out according to the syntax with the learning method of the teacher delivering the learning material directly, students in groups discussed the learning material then displayed the results of the discussion in front of the class, students in groups made joint work in the form of posters about waste management and displayed the work, then students in groups discussed the material then put the results into *power point* then presented the results in front of the class. Students in the control class used printed physics learning books as learning resources.

In the experimental class, learning was conducted using interactive multimedia based on the cognitive conflict learning model. The application of this interactive multimedia approach helped enhance students' understanding of concepts and address any misconceptions they had (Zuwita & Mufit, 2023). Learning takes place following the stages or syntax of cognitive conflict models (Mufit, 2018). The first stage in the cognitive conflict learning model is the activation of preconceptions and misconceptions. At this stage students are given questions about the greenhouse effect, to see students' initial understanding of the learning material and to attract more attention from students about the material to be taught. This can make it easier for teachers to map students in terms of initial understanding of global warming material. The second syntax is the presentation of cognitive conflict. At this stage students are presented with a series of unusual events regarding global warming so as to bring up conflicts of understanding or new ideas in students about global warming material before carrying out the process of conceptual change and discovery of new information for students.

The third stage is concept discovery. In the interactive multimedia, two interesting animated videos explaining the greenhouse effect and what causes global warming are presented. Physics learning that is abstract will be easier to learn when starting from something concrete or real (Haryanti et al., 2019). The concept of global warming symptoms itself is a complex material because it is abstract, so students need an explanation using animation in order to illustrate how the concept of global warming occurs properly. Video presentation of related learning materials can improve students' concept understanding and correct concept errors in students, for example the integration of real experiment videos in e-books on motion kinematics material which is effective in improving students' concept understanding (Mufit et al., 2022). After the video presentation, students were given three experiments with different objectives, including to find out the function of clouds on the earth's temperature, the substances that make up greenhouse gases and their properties, and the effect of the number of layers of greenhouse substances on the earth's temperature. This experiment was carried out by students using a virtual laboratory and the experimental results were written in the column available in the interactive multimedia. Integrating virtual laboratories into interactive multimedia enhances twenty first century learning skills, enabling students to engage in more effective and immersive learning experiences. This approach helps achieve learning objectives more efficiently by fostering critical thinking, problem-solving, and hands-on exploration (Mufit, Hendriyani, et al., 2023). he fourth stage is reflection. At this stage checking is done on the students, whether the material that has been given can be understood and arrived well at the students or not, also to see whether the conceptual errors that previously occurred in students have been resolved or not. Students are given questions about the learning that has been done using interactive multimedia based on cognitive conflict.

It can be seen the difference in treatment given to the experimental class and the control class. In the control class, students learn using printed books, then discuss with friends in groups, and the teacher explains the material with power point media. In learning, students are guided and directed by the teacher in finding information and also reading from source books, afterwards discussing with friends in groups. Whereas in the experimental class, students learn structured with the help of interactive multimedia, in which there are already instructions for use, students can ask the teacher also there are doubts when using cognitive conflict-based multimedia.

Students in the control class learned according to the order of the material in the printed book and worked with groups according to the syntax of the cooperative model, while students in the experimental class learned according to the syntax of the cognitive conflict model, where students were faced with problems and found their own concepts by conducting experiments in a virtual laboratory, where students became more active in thinking than just discussing with group friends.

Learning with the help of interactive multimedia makes students who initially experience errors in concepts or knowledge about global warming material can find the correct concept of the concept of global warming, seen from the value on the posttest which increases compared to the pretest value. Control class students also experienced concept improvement after learning seen from their posttest scores, and were still lower than the experimental class scores, seen in Table 1. Then seen from the retest scores of experimental class students only experienced a slight decrease in scores compared to control class students, this shows that learning using interactive multimedia is more imprinted on students' memories on global warming material than just listening to the teacher or friends who explain in front of the class. As a result, the experimental class demonstrated higher retention values than the control class. This indicates that interactive multimedia based on the cognitive conflict learning model had a positive effect on student retention, outperforming the traditional teaching method used in the control class. This aligns with research on the effectiveness of cognitive conflict learning models in addressing misconceptions. The findings indicate that these models significantly contribute to improving students' conceptual understanding and correcting their misconceptions (Mufit, Festiyed, et al., 2023).

CONCLUSION

The research findings revealed that students in the experimental class, who were taught using interactive multimedia based on cognitive conflict, demonstrated higher retention compared to those in the control class. Although some memory decline was observed in the experimental class over time, it was less pronounced than the decline seen in the control class. Hypothesis testing, performed at a 0.05 significance level, confirmed that the use of interactive multimedia had a significant impact on student retention of global warming material, especially when compared to traditional learning methods. This suggests that interactive multimedia based on cognitive conflict is an effective tool for enhancing long-term retention in students.

REFERENCES

Agustianda, S., Nazip, K., Genisa, M. U., & Sumah, A. S. W. (2024). *Pengaruh Direct Instruction Dan SQ3R Terhadap Retensi Siswa Dalam Pembelajaran Biologi Agustianda , dkk – Pengaruh Direct Instruction Dan SQ3R Terhadap Retensi Siswa Dalam*. *10*, 449–456.

Akwantin, Y. T., Hidayati, Y., Qomaria, N., Muharrami, L. K., Rosidi, I., Kunci, K., Kemampuan, :, Kritis, B., Global, P., & Menengah Pertama, S. (2022). Profil Tingkat Kemampuan Berpikir Kritis Siswa Smp Pada Materi Pemanasan Global. *Jurnal Natural Science Educational Research*, *5*(1), 20–30.

Djatmika, E. T., & Praherdhiono, H. (2024). *Belajar Matematika Lebih Menyenangkan : Pengembangan Multimedia Interaktif berbasis Gamifikasi untuk Operasi Bilangan Bulat*. *13*(4), 5045–5060.

Hamid, A., & Alberida, H. (2021). Pentingnya Mengembangkan E-Modul Interaktif Berbasis Flipbook di Sekolah Menengah Atas. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(3), 911–918.

Hardani, Auliya, N. H., Andriani, N., Fardani, R. A., Ustiawaty, J.,Utami, E. F., Sukmana, D. J., I. R. R. (2020). *Metode Penelitian Kualitatif & Kuantitatif* (H. Abadi (ed.); Cetakan I,). Pustaka Ilmu.

Haryanti, N., Widodo, A. T., & Arfiani, Y. (2019). Penerapan Model Discovery Learning pada Materi Pemanasan Global untuk Meningkatkan Keterampilan Berpikir Kritis Peserta

Didik. *Jurnal Edukasi Matematika Dan Sains*, *7*(2), 55.

Hasanah, N., Hidayat, A., & Koeshandayanto, S. (2020). Pengaruh Strategi Konflik Kognitif Ditinjau dari Kemampuan Awal Siswa untuk Mengurangi Miskonsepsi pada Materi Gelombang Mekanik. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5*(5), 624.

Hernacki, B. D. P. M. (2010). *Quantum Learning*. PT Mizan Publika. https://books.google.co.id/books?id=iAurOAjxMBgC

Kartika, H., Desnita, Festiyed, & Suherman, D. S. (2022). *Indonesian Research Journal on Education : Jurnal Ilmu Pendidikan*. *2*(3), 1030–1037.

Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisis Bahan Ajar. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(2), 311–326.

Mamonto, F. (2024). *Efektivitas Media Gambar terhadap Retensi Penguasaan Kosakata Bahasa Arab Tingkat Madrasah Tsanawiyah di Sulawesi Utara*. *04*, 39–50.

Mufit, F. (2018). *Model Pembelajaran Berbasis Konflik Kognitif (PbKK) untuk Meningkatkan Pemahaman Konsep dan Meremediasi Miskonsepsi*. 37.

Mufit, F., Asrizal, Puspitasari, R., & Annisa. (2022). Cognitive Conflict-Based E-Book With Real Experiment Video Analysis Integration To Enhance Conceptual Understanding of Motion Kinematics. *Jurnal Pendidikan IPA Indonesia*, *11*(4), 626–639.

Mufit, F., Festiyed, F., Fauzan, A., & Lufri, L. (2018). Impact of Learning Model Based on Cognitive Conflict toward Student's Conceptual Understanding. *IOP Conference Series: Materials Science and Engineering*, *335*(1).

Mufit, F., Festiyed, Fauzan, A., & Lufri. (2023). The Effect of Cognitive Conflict-Based Learning (CCBL) Model on Remediation of Misconceptions. *Journal of Turkish Science Education*, *20*(1), 26–49.

Mufit, F., Hendriyani, Y., Usmeldi, Dhanil, M., & Tanjung, M. R. (2023). The Effectiveness of Smartphone-Based Interactive Multimedia Integrated Cognitive Conflict Models to Improve 21st-Century Skills. *International Journal of Information and Education Technology*, *13*(11), 1793–1801.

Ningsih, E. H. A. W., Studi, P., Fisika, T., Pendidikan, J., Pengetahuan, I., Ilmu, F., Dan, T., Islam, U., & Syarif, N. (2019). *Pengaruh Multimedia Interaktif*.

Pramono, A., & Mufit, F. (2022). Design of Cognitive Conflict-Based Interactive Multimedia Using Adobe Animate CC 2019 On Global Warming Materials. *Jurnal Geliga Sains: Jurnal Pendidikan Fisika*, *10*(2), 89.

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1).

Sari, D. N., Arif, K., Yurnetti, Y., & Putri, A. N. (2024). Identification of Students' Misconceptions in Junior High Schools Accredited A using the Three Tier Test Instrument in Science Learning. *Jurnal Penelitian Pendidikan IPA*, *10*(1), 1–11.

Sarnoto, A. Z., Rahmawati, S. T., Ulimaz, A., Mahendika, D., & Prastawa, S. (2023). Analisis Pengaruh Model Pembelajaran Student Center Learning terhadap Hasil Belajar: Studi Literatur Review. *Jurnal Pendidikan Dan Kewirausahaan*, *11*(2), 615–628.

Waraulia, A. M. (2020). Bahan Ajar Teori dan Prosedur Penyusunan. *UNIPMA Press*, 1–59.

Wulandari, A. P., Salsabila, A. A., Cahyani, K., Nurazizah, T. S., & Ulfiah, Z. (2023). Pentingnya

Media Pembelajaran dalam Proses Belajar Mengajar. *Journal on Education*, *5*(2), 3928–3936.

Zuwita, N., & Mufit, F. (2023). The Effectiveness of Cognitive Conflict-Based Learning Models Using Interactive Multimedia. *Pillar of Physics Education*, *15*(1), 120–126.