The Effectiveness of Cognitive Conflict-Based Learning Models Using Interactive Multimedia

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ABSTRACT

The cognitive conflict learning model can be used to improve student understanding of concepts, 21st century developments demand IT-assisted learning. Several studies have shown that understanding of physics concepts is low resulting in misconceptions, one of which is sound and light waves. The solution to these problems is integration using cognitive conflict-based learning models assisted by interactive multimedia. Interactive multimedia is a system for implementing cognitive conflict-based learning models, because it has the same goal of increasing students' conceptual understanding. Cognitive conflict-based learning models can improve students' conceptual understanding and remediate misconceptions because they have 4 skills, namely preconception and misconception activities, presentation of cognitive conflicts, discovery and concept similarities, and reflection. The purpose of this study was to analyze the effectiveness of cognitive conflict-based learning models on students' understanding of the concept of sound and light waves. This study used an experimental method with a quasi-experimental type. The sample consisted of 65 high school students with two sample classes namely the experimental class and the first control class which were selected by purposive random sampling technique. The instrument in this study was a valid concept, the data were obtained with the help of IBM SPSS 20 statistics, the results obtained were sig.asim < 0.05 which is included in the Ho rejection area, that cognitive conflict-based learning models affect students' conceptual understanding of sound and light waves Thus, the cognitive conflict-based learning model assisted by interactive multimedia is effective for use in remediating misconceptions and increasing students' conceptual understanding.

Keywords: cognitive, conflict, sound ang light waves, interractive multimedia, effectiveness

I. INTRODUCTION

The development of information and communication technology in the 21st century is very rapid, including in the learning process which has entered the modern era. The ability to think critically, solve problems, and collaborate are competencies that need to be honed in entering 21st century educational life. Education has an important role in improving skills in the 21st century, schools are required to be able to prepare and hone students' abilities to face the era of educational technology development in the 21st century [1].

Curriculum is one of the important components that influence the success of the learning process. Curriculum development, Indonesian education is currently implementing education with the 2013 curriculum [2], namely from the education unit level curriculum (KTSP) to the 2013 curriculum and the curriculum currently used is the 2017 revised edition of the 2013 curriculum [3]. Application The revised 2013 curriculum requires teachers to develop learning through cohesiveness four main pillars. Wrong only one is a skill for 21st century technology, so that the government held a teacher certification program and provided facilities and infrastructure in stages to support the learning process in schools by using IT or appropriate technology with developments and demands of the 21st century [4]. Teachers can realize learning activities student-centered through interactive multimedia. Interactive multimedia is a teaching material that combines various media and

In the 2013 curriculum , students' understanding of concepts is one of the objectives of learning physics, so educators need to know students' understanding of concepts, and educators can detect whether misconceptions occur in students' understanding, therefore solutions or remediation are found if misconceptions occur [5]. The aim of learning Physics is to develop the ability to think inductively and deductively by using the concepts and principles of physics to explain various natural events and solve various problems both qualitatively and quantitatively.

The low understanding of students' concepts that causes misconceptions, including the material on sound and light waves in senior high school who makes the learning process hampered t because of a clash between the wrong old concept and the correct new concept [6]. The problem of misconceptions and students' low understanding of concepts is also a problem that often occurs in physics learning [7], the use of concepts that are not in accordance with the concepts of experts or scientists who have been accepted scientifically [8]. Many students experience misconceptions, namely associative views, humanistic views, incomplete reasons, and wrong instincts that hinder student learning [2]. From the start there was no improvement so that misconceptions persisted and hindered the further learning process [9]. Cognitive conflict is a student's condition when given concepts or information that conflict with existing concepts or information [8], so thatcognitive conflict is defined as a problem that exists in students' minds through observing a phenomenon in finding a new correct concept. Educators are tasked with making students aware of the misconceptions that occur, so that students can finally rebuild scientifically correct concepts, cognitive conflict-based learning model assisted by interactive multimedia, where the CCBL model is a learning model specifically designed by Mufit & Fauzan (2019) to remediate misconceptions [10]. Cognitive conflict-based learning can increase conceptual understanding, reduce the occurrence of misconceptions, help understanding, properly instill new concepts, and store them in memory , so that cognitive conflicts are accurately used to improve conceptual understanding of physics in the learning process.

For this reason, a quasi-experimental research was carried out, namely by using a cognitive conflict-based learning model assisted by interactive multimedia, which is based on developments and demands of the 21st century, because multimedia is a support system so that the learning model that will be used is implemented. This study aims to analyze the effectiveness of cognitive conflict-based learning models assisted by interactive multimedia on students' conceptual understanding of sound and light waves.

II. METHOD

The type of research to be carried out is a quantitative experimental research with a *quasi-experimental* (quasi-experiment). It is said to be pseudo because it does not yet have the characteristics of the actual experimental design and cannot be regulated by researchers (humans). So that the validity of the research is not sufficient enough to be called an actual experiment.

The experimental research procedure consisted of 3 stages, namely: 1) the preparation stage, 2) the implementation stage, 3) the assessment stage, by determining the population and sample consisting of the control class and the experimental class as seen from the 3 populations of class XI IPA in a senior high school, the sample class is determined by drawing lots from the results of the Mid Semester Assessment in table 1.

Table 1. results of the Mid Semester Assessment

No	Class	Number of Class	Averagescores Student
1	XI Science 1	31	84
2	XI Science 2	31	84
3	XI Science 3	31	85

Take 2 classes that have the same learning outcomes. By carrying out a normality test to see whether the sample consists of a normally distributed population or not. The normality test was carried out with the help of IBM SPSS 20 statistics, it was found that class XI 1 Science class and XI 2 Science class had normality test results <0.05 where H_0 was rejected.

III. RESULTS AND DISCUSSION

Table 2. Analysis Test Result Stat Characterstics the Experimental Class and Control Class

No	Tested	Test type	Result	Table	Conclusion
1	Normality	Test liliefors	0,000 and 0,000	0,814 and 0,790	Ho rejected
2	Homogeneity	Test F	0,403	0,708	Homogeneneus Data
3	Similarity of the two class means	Test Mann Whitney	0,724	0,05	same initial ability

Perform homogeneity tests on both sample classes to see whether the two classes have homogeneous variations or not. With the help of IBM SPSS 20 statistics, the class results have a homogeneous variance > 0.05, namely 0.403.

Perform a similarity test of two means, this step is carried out to find out whether the two sample classes have the same initial ability or not. After obtaining the normality test results which are not normally distributed and the homogeneity test which has a homogeneous variant. Then the similarity test of the two averages carried out is the U test. The following is the similarity test of the two averages using the U test, the result is > 0.05, which is 0.724 so that the two samples have the same initial ability before being given a treatment.

Before being used as a research instrument, the concept test was tried out in one class (XI 3 Science class). Testing was carried out to see the validity, reliability, difficulty index, and discriminating power of the concept test questions to be carried out. Of the 20 questions given, only 10 questions were feasible to use. At the end after treatment using cognitive conflict-based learning models assisted by interactive multimedia for experimental classes, and without treatment using learning models commonly used in schools using printed teaching materials or LKS for the control class. The test scoring rubric was prepared to determine the level of students' understanding of concepts including misconceptions. The combination of objective option answers, level of confidence and reasons were categorized into understanding concepts, misconceptions, and not understanding concepts.

This study used two sample classes, namely the control class XI 2 Science class and the Experiment class XI 1 Science class. The distribution of sample classes in this field test can be seen in table 3.

Table 3. Sample class in the *field test*

Class Sample	Numberof	Treat-ment	*Posttest*
Experiment	31	X	Test Concept
Control	31	-	Test Concept

Description : X = treatment given

Treatment in the experimental class using teaching materials based on cognitive conflict in the material of sound and light waves. In the control class using teaching materials that are applied in schools. Before and after learning, the two sample classes were given a *posttest* using a concept test instrument on sound and light waves which had previously been subjected to test-test analysis. The concept test is stated to have content validity with high, medium, low and very low criteria. The reliability of the concept test was tested through the Kuder-Richaderson equation (KR 21) with the high category. The difficulty index and the differential power of the concept test are also in the easy, medium and difficult criteria.

The effectiveness of cognitive conflict-based learning models can be seen by comparing the level of students' understanding of concepts in the experimental class and the control class. After the students had followed all the learning processes, the two samples were given a *posttest* to see the effectiveness of the teaching materials used. Here are some examples of student answers in completing the test questions given.

Fig. 1. Concept Understanding Category (U) Student Answer Sheets in Solving Sound and Light Wave Concept Problems.

Fig. 2. Misconception Category (M) Student Answer Sheets in Solving Sound and Light Wave Concept Problems.

10. Sonometer merupakan sebuah alat bantu penala dan digunakan dalam laboratorium fisika sebagai alat penguji nilai frekuensi peralatan. Urutan yang benar dalam penggunaan sonometer adalah:

1) Memilih basis frekuensi

2) Menentukan skala

3) Memasukkan serangkaian catatan di skor lapangan

4) Memasukkan chords ke skor

5) Menentukan modus

6) Mencatat masing-masing hasil skor

A. (3), (5), (1), (4), (6)   B. (4), (1), (3), (5), (6)

C. (1), (2), (3), (4), (5)   D. (4), (3), (2), (1), (6)

E. (6), (5), (3), (4), (1)

Apakah ananda yakin dengan kebenaran jawaban ananda?

a. Sangat yakin   b. Cukup yakin   c. Kurang yakin   d. Tidak yakin

Beri alasan atas jawabananananda&tulis persamaan yang digunakan:
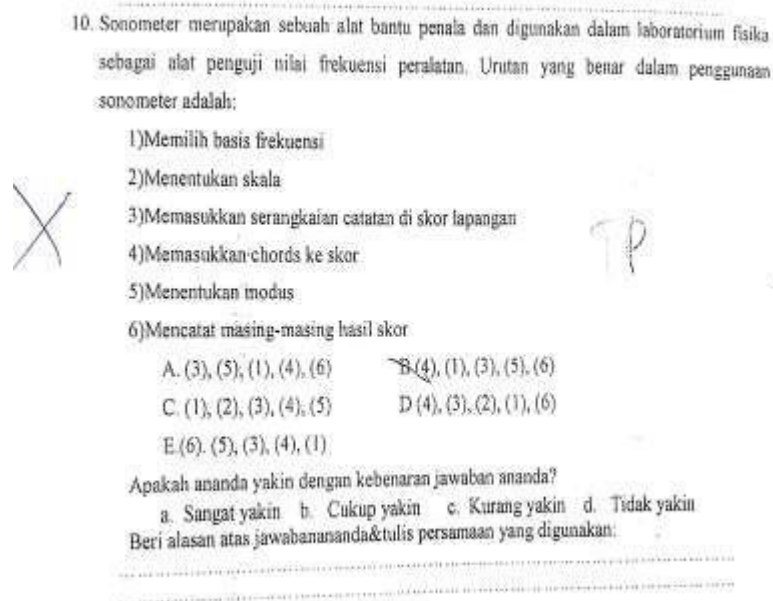
Fig. 3. Categories of No Understand (NU) Student Answer Sheets in Solving Problemsof the Concept of Sound and Light Waves.

On fig. 1 example of a student's posttest answer sheet including the category of understanding the concept, fig. 2 examples of student answer sheets in the category of misconceptions, fig. 3 examples of student answer sheets in the category of not understanding the concept. the group of students' understanding level consists of 3 simplified categories, namely: understanding concepts, misconceptions, and not understanding concepts. [8]

The posttest of the two sample classes were processed using the percentage technique. Concept test data given to students were in the form of two-level multiple choice questions and analyzed using the level of students' understanding of concepts in three categories, namely: understanding concepts (P), misconceptions (M), and not understanding concepts (TP). To see the effectiveness of cognitive conflict-assisted teaching material products on the material of sound and light waves in the learning process, the following is a *posttest* students for the two sample classes categories are shown in Table 4, The following.
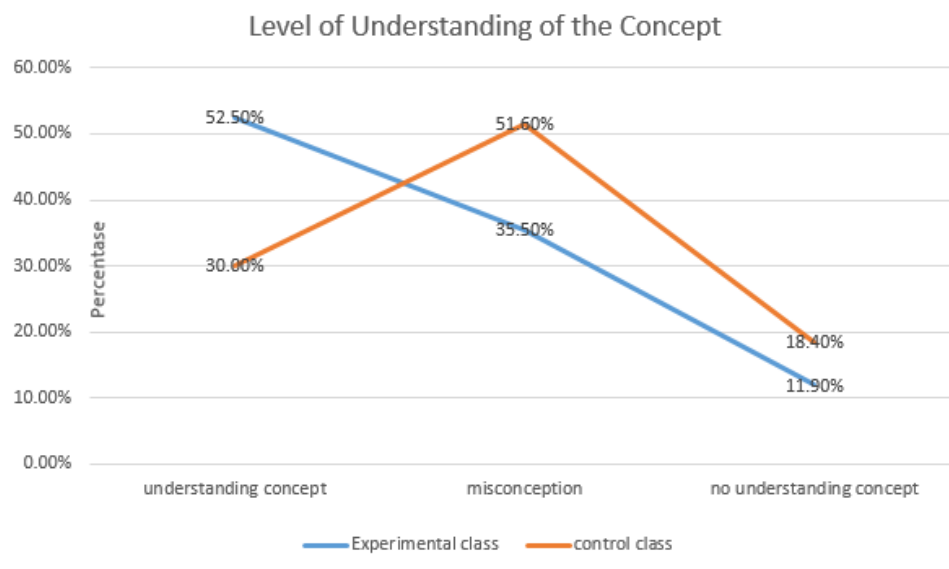

Fig. 4. Posttest comparison of sample Categories U, M and NU Sample.

In Figure 4, the data obtained were analyzed using the test Mann-Whitney, because the prerequisites for the differential test have been fulfilled, namely the data is not distributed normally. The following results of the analysis using the IBM SPSS statistics 20 for the U, M, and NU categories are shown in Table 4. The following

Table 4. Posttest Normality Test Results for classes in categories U, M and NU

Category	Class	Statistics	df	Sig.	Description
Understanding (U)	Control	0.936	31	0.064	Normal
	Eksperiment	0.936	31	0.063	Normal
Misconception(M)	Control	0.928	31	0.040	Abnormal
	Eksperi-ment	0.919	31	0.022	Abnormal
Not Understand (NU)	Control	0.913	31	0.016	Ab normal
	Eksperiment	0.785	31	0.000	Abnormal

Based on table 4 for the concept understanding category (U) has a significance value (sig.) of more than 0.05 so that it is normally distributed, the category of misconceptions (M), not understand the concept (NU) has a significance value (sig.) less than from 0.05 so that it is not normally distributed. Because some populations are not normally distributed, the statistic used is non-parametric static, namely the Mann test is used Whitney (U). Test the analysis results obtained from the Mann-Whitney test for the experimental class and control class can be seen in the following table 5.

Table 5. Posttest U-test results for categories U, M, and NU sample class

No	Aspect	Value		
		U	M	NU
1	Mann- Whitney U	125.500	205.500	293.500
2	WilcoxonW	621.500	701.500	789.500
3	Z	-5.067	-3.973	-2.818
4	Sig. Asim.(2-tailed)	0.000	0.000	0.005
	Description	Sig. Asim. < 0.005		
		H_o is. Rejected		

Based on the data in table 5 above, it can be seen that the population in the category level of understanding, both understanding concepts (U), misconceptions (M), and not understanding concepts (NU) has an asymptotic significance value *(Asymp. Sig.) whose* value is less than 0 .05 so that the null hypothesis (H_o) is rejected or acceptance of H_1. So the results of the study show that there is an influence on cognitive conflict-based learning models assisted by interactive multimedia in the material of sound and light waves on the level of students' understanding of concepts.

IV. DISCUSSION

Based on the results of hypothesis testing can be seen at the level of student understanding. Cognitive conflict-based learning model assisted by interactive multimedia in increasing high school students' conceptual understanding is effective and can be used in the learning process. Interactive multimedia-assisted learning is very valid and appropriate for use in improving students' understanding of concepts. The effectiveness of the cognitive conflict-based learning model is obtained by refusing to test the hypothesis, in the experimental class the percentage increases understanding of concepts, the percentage of misconceptions decreases, the percentage of students who do not understand concepts in the experimental class decreases. Students' understanding of concepts is further improved by using cognitive conflict-based learning models assisted by interactive multimedia, because the cognitive conflict learning model consists of 4 syntaxes, namely 1) preconception and misconception activities, 2) presentation of cognitive conflict, 3) discovery and concept equations, and 4) reflection, cognitive conflict-based learning (CCBL) is valid and appropriate to use because this model is effective in increasing conceptual understanding and remediating misconceptions [11]. Based on the results of the study, researchers highly recommend cognitive conflict-based learning models assisted by interactive multimedia in increasing understanding of the physics concepts of sound and light waves in the 21st century, because it increases conceptual understanding and remediates misconceptions.

V. CONCLUSION

Based on the results of the research and discussion that has been done, it can be concluded that the use of cognitive conflict-based learning models assisted by interactive multimedia on sound and light waves is effective in increasing students' understanding of concepts. This is evidenced from $H0_{being}$ rejected which was obtained in carrying out the Mann-Whitney test (U-Test).

REFERENCES

[1]   M. Dhanil and F. Mufit, "*Design and Validity of Interactive Multimedia Based on Cognitive Conflict on Static Fluid Using Adobe Animate CC 2019*," *J. Penelit. Pengemb. Pendidik. Fis.*, vol. 7, no. 2, pp. 177–190, 2021, doi: 10.21009/1.07210.

[2]   S. F. Anggraini *et al.*, "*The Validity of Interactive Multimedia Based on Cognitive Conflict on Elasticity Materials Using Adobe Animate CC 2019*," vol. 8, no. 1, pp. 13–22, 2022.

[3]   R. Defrianti, F. Mufit, Gusnedi, W. S. Dewi, and Z. Hidayat, "Design of Cognitive Conflict-Based Teaching Materials Integrating Real Experiment Video Analysis on Momentum and Impulse to Improve Students' Concept Understanding," *Pillar Phys. Educ.*, vol. 14, no. 2, pp. 97–108, 2021.

[4]   S. I. Ana, "*Effect Size Of Model Application React On Physics Student ' S Achievement*," vol. 15, no. 4, pp. 296–300, 2022.

[5]   R. Puspitasari, F. Mufit, and Asrizal, "Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic," *J. Phys. Conf. Ser.*, vol. 1876, no. 1, 2021, doi: 10.1088/1742-6596/1876/1/012045.

[6]   A. S. Widiastuti and J. Purwanto, "Remediasi Miskonsepsi Pada Materi Gelombang Bunyi Dengan Pendekatan Konstruktivisme Metode 5E Di SMA N 1 Turi," *Pros. SNFA (Seminar Nas. Fis. dan Apl.*, vol. 4, no. 2000, p. 25, 2019, doi: 10.20961/prosidingsnfa.v4i0.35909.

[7]   V. Pratama, S. F. Anggraini, H. Yusri, and F. Mufit, "Disain dan Validitas E-Modul Interaktif Berbasis Konflik Kognitif untuk Remediasi Miskonsepsi Siswa pada Konsep Gaya," *J. Eksakta Pendidik.*, vol. 5, no. 1, pp. 68–76, 2021, doi: 10.24036/jep/vol5-iss1/525.

[8]   F. Mufit, A. Asrizal, and R. Puspitasari, "Meta-Analysis of the Effect of Cognitive Conflict on Physics Learning," *J. Penelit. Pengemb. Pendidik. Fis.*, vol. 6, no. 2, pp. 267–278, 2020, doi: 10.21009/1.06213.

[9]   R. Entino, E. Hariyono, and N. A. Lestari, "Analisis Miskonsepsi Peserta Didik Sekolah Menengah Atas pada materi Fisika," *PENDIPA J. Sci. Educ.*, vol. 6, no. 1, pp. 177–182, 2021, doi: 10.33369/pendipa.6.1.177-182.

[10]   I. Luthfi, F. Mufit, and M. R. N. Putri, "Design of Physical Teaching Materials Based on Cognitive Conflict Learning in Direct Current Electricity Integrating Virtual Laboratory," *Pillar Phys. Educ.*, vol. 14, no. 1, p. 37, 2021, doi: 10.24036/10771171074.

[11]   F. Mufit and A. D. Fitri, "The Analysis of Experiment Video on Cognitive Conflict- Based Teaching Materials to Enhance Momentum-Impulse Concepts Understanding," vol. 8, no. 2, pp. 293–304, 2022.