Improving Student's Skills and Concept Understanding in Vibration and Waves with the Use of Visual Media Concepts on Students

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Abstract: This research was conducted to determine the effectiveness of the media in improving science process skills. The effectiveness of visual media was further investigated using the Quasi-Experimental method with a pre-post test control group design. Learning is carried out using a cooperative model of investigative group type. The population is all students of class VIII of one junior high school in West Java academic as many as 324 students. This study aims to develop GI type cooperative learning to improve students' process skills and concept mastery. Science was compiled using cooperative learning with group investigation, but non-visual media in the control class. The results showed that visual media can improve science process skills and mastery of vibration and wave material concepts. It can be seen that the N-Gain value is 55% for science process skills (medium category) and 67% (medium category) for concept mastery. Conclusion of the research can be seen that the use of visual media material vibrations and waves in cooperative learning investigative group type can improve skills, mastery of concepts and motivate students to be active in learning compared with investigative group type cooperative learning without the use of visual media.

Keywords: Concep Mastery, Science Process Skills, Vibration and Wave, Visual Media

INTRODUCTION

Science learning plays a very important role in building students' character in science and technology. This condition requires science learning with good quality in order to keep up with the science and technology development in society. Science learning that is full of thinking activities can be a vehicle for training students to master science, concepts, and principles, have scientific skills, build abilities and skills so that they can improve the quality of human resources. The formation of thinking skills will be very decisive in building the personality

and action patterns of students. However, the learning process is still dominated by the teacher and does not provide access for students to develop independently through discovery and thought processes (Suendarti & Liberna, 2018; Peranginangin *et al*., 2019; Anggereini *et al*., 2021)

Science learning is an effort to prepare students to face the challenges of life in the future by training their thinking skills. One of them is characterized by process skills which are thinking skills, learning types and metacognitive skills. With these skills and abilities, students' creativity hopefully will increase to solve life's competitive problems.

Learning science in most schools in Indonesia seems to be a burden for students. This condition happens because the teacher dominates the learning process and does not provide access for students to develop independence through discovery and thought processes. As a result of this situation, students' process skills are less developed. In fact, the KTSP and the 2013 curriculum have emphasized that it is students who play an active role in building their abilities, skills, and knowledge (Hadi, 2015).

According to the observations on science learning that the researchers conducted in one of the public junior high schools in Cianjur, it was shown that the opportunity to train students' science process skills in learning was still not maximized. There was a lack of opportunities to develop students' questions in building and practicing logical inference and mathematical application in solving problems given in learning. In general, student activities only listen to the teacher teaching and work on the questions given by the teacher. Students learn more passively and can't apply and explain physical phenomena in everyday life. The results of a preliminary study interview with one of the science teachers at one of the public junior high schools in Cianjur revealed that the learning model usually applied is the conventional one where the teacher uses the lecture method more and emphasizes problem-solving exercises.

One of the improvement efforts is to apply a learning model that can increase student learning activities. Various learning models can play as learning facilities to improve science process skills and mastery of concepts. Cooperative learning, learning in interactive multimedia, and problem-based learning are the learning which can accommodate the improvement of science process skills (SPS) and students' mastery of concepts. The cooperative learning model of the investigative group type using visual media is relevant to use in science classes in junior high schools.

The cooperative learning model with the investigative group (IG) type is one of the learning models that can improve student learning activities. The advantages of IG type are to give freedom to students to think analytically, critically, creatively, reflectively, and productively (Supena & Hariyadi, 2021).

The results of research by Sari *et al*., (2018); Herlina *et al*., (2022) found that investigative group-type cooperative learning can improve students' conceptual understanding. Based on the characteristics and stages in the IG type of cooperative learning model, it appears that the IG type of learning model can lead students to develop all their skills and abilities in the learning process. The learning process becomes student-centered so the teachers can optimize their roles as facilitators and mediators.

Increasing students' mastery of concepts and science process skills can be further optimized by applying the investigative group cooperative learning model using visualization media. Visualization media is an appropriate learning media for abstract material. One material that is very suitable for applying visualization media is vibration and wave material. Learning with visual media is very useful in science learning, especially in overcoming the limitations of laboratory work and explaining materials that contain many misconceptions (Ramos *et al*., 2021). In addition, the results of research conducted by Gunawan *et al*., (2019); Dasilva *et al*., (2019) and Cetin, (2020) stated that visualization media helps students understand phenomena and problem solving to improve students science process skills and mastery of concepts.

Based on the description above, it is interesting to study the development of learning models that are expected to improve science process skills and mastery of concepts in junior high school students. This effort is to train and improve students' process skills and conceptual mastery. Therefore, the effectiveness of visual media in Investigative Type Cooperative Learning to Improve Science Process Skills and Concept Mastery of Students needs to be developed and researched. This is in accordance with the purpose of this study, namely developing cooperative learning type IG to improve process skills and mastery of students' concepts. Vibration and Waves are science materials in junior high schools that have the potential to be developed through investigative group-type cooperative learning, with reinforcement on experiments and visualization of abstract concepts that are generally difficult for students to understand.

This research is important because in this study an experiment was carried out on the development of science material in junior high schools, namely vibration and material waves that have never been developed before, including the discussion of waves that have interesting characteristics for students to understand, including waves that can be: reflected (reflection), can be refracted (refraction), can be deflected (diffraction), decomposition (dispersion), interference, polarization, and the Dofler effect.

METHODS

The method used in this study is a quasi-experimental method with a non-equivalent control group research design (Wibowo & Pelipa, 2018). The characteristic of quasi-experimental is the presence of an experimental group and a control group who are both given a pretest and posttest, and the experimental group and control group will receive different treatments (Fraenkel, 2012).

Table 1 Pretest-Posttest Control Group Design

Class	Pretest	Treatment	Posttest
Experiment	O_1 O_2	X	O_1 O_2
Control	O_1 O_2	C	O_1 O_2

To answer the research questions and test research hypotheses, the data needed in this study is the students' conceptual mastery obtained from the concept mastery test instrument and student process skills data obtained from the process skills test instrument. The research instrument used were in the form of pretest and posttest. Supporting data needed are data regarding the implementation of the learning model in both the experimental class and control class obtained from the observation instruments and data regarding student responses during the learning process obtained from the questionnaire instrument.

The test instruments (concept mastery and SPS) previously tested to determine validity, reliability, discriminating power, and level of difficulty before used in the study. The instrument trial was conducted on class IX students. The data from the test results were then analyzed to obtain information about whether or not the test instrument was used in the study.

The test trials were conducted on IX grade junior high school students in one of the schools in Cianjur. The number of questions tested were 42 questions consisting of 27 multiple choice questions for the concept mastery instrument and 15 multiple choice questions for the science process skills instrument. Analysis of the instrument by determining the reliability of the test, the level of difficulty, and the differentiating power of the questions. Based on the results of the calculation of the reliability of the concept knowledge instrument statistically, that is by calculating the correlation between the first and second trials, so that the reliability results for the concept mastery test are 0.641.

The concept mastery instrument, from the calculation of the level of difficulty obtained 22 items in the medium category, and 5 items in the easy category. While the discriminatory power of the concept mastery test questions obtained 9 items categorized as good, 15 items categorized as sufficient and 2 items categorized as bad and 1 very bad.

RESULTS AND DISCUSSION

The implementation of a learning model can be seen from the implementation of the Learning Program Plan (RPP) during the learning activities. Observations were made in the form of teacher activities teaching and student activities as students, namely statements carried out and not carried out in the learning stages, there were also columns of information and suggestions from the observer.

The implementation of the use of visualization media in cooperative learning with the type of Investigation Group from observations made on teacher activities and student activities during the learning process which lasted three meetings consisting of three subtopics. Observations of observers (peer teachers as many as 3 people) are written in the available observation sheets, namely the observation sheet on the implementation of cooperative learning with the application of visualization media. The three sub-topics discussed are the first vibration, the second: waves, and the third: the use of wave reflections in everyday life. Each of these stages provides an overview of the extent to which teachers and students follow this stage.

In this study, the learning process carried out was observed by three observers at each meeting. The observers were three science teachers at a public junior high school in Cianjur regency. This observation was carried out to ensure that the use of visualization media in the Investigation Group type cooperative learning was carried out according to the plan. Based on the observation sheet filled in by the observer, it was found that the level of implementation of the use of visualization media in cooperative learning of the Investigation Group type by the teacher at each meeting was 92%. Meanwhile, the implementation of the use of visualization media in cooperative learning of the Investigation Group type by students was 94.7%. Thus, most of the learning models are carried out in accordance with the stages.

Based on the results of the study, it was shown that the implementation of the use of visualization media in cooperative learning of the Investigation Group type by the teacher could be carried out well. This can be seen from the teacher's activities at the learning stage. In general, 94% of teachers always convey learning objectives when starting learning activities, then most of 89% of teachers carry out apperception activities by asking questions related to the topic to be taught. Thus, the teacher's activities in the initial activities filled with the delivery of learning objectives and apperception can be carried out properly.

In the main learning activities, in general 95% of teachers present information through visualization media clearly, and then the teacher guides students in discussion activities. Thus the core learning activities are filled with information presentation activities and guidance to students is carried out

properly. Based on the results of observations at the end of learning activities, it shows that most (96%) of teacher activities in evaluating through the stage of providing opportunities for students to present the results of discussions and then together with students draw conclusions. Thus, closing activities in learning can be carried out properly.

In addition to observing teacher activities in learning, observations were also made on student activities during vibration and wave learning through investigation group type cooperative learning, see attachment 6. The results of observations made by three observers during three meetings. Based on the results of observations on the implementation of the process of using visualization media in cooperative learning of the Investigation Group type, visualization media plays a very important role in an interactive and communicative learning atmosphere. This can be seen during the learning process, where students are very enthusiastic and have high enthusiasm in carrying out the stages in learning. During the activity in groups, the teacher only acts as a mediator and facilitator.

This is in accordance with the opinion expressed by Munawwarah & Khaldun, (2016); Dasilva & Ardiyati, (2019); Fajra & Novalinda, (2020) which states that the principle of learning which is based on constructivism, the teacher should act as a mediator and facilitator. Such learning helps the teaching and learning process run well and students actively build their own knowledge. In addition, teachers are required to create and guide students to actively learn to express their ideas and concepts, so that the concepts learned will be remembered longer and can improve student achievement.

In observing and simulating the visualization media, students work actively, the teacher provides guidance to students in solving problems in the worksheet. After conducting discussions between groups, then the teacher together with students draw conclusions from the observations. The application of visualization media in learning is able to develop several aspects of the ability to manage learning carried out by teachers and foster student interest in learning. Students who conduct observations and simulations of visualization media independently and are directly involved in the learning process can encourage the development of thinking skills.

Based on research findings through observations that the implementation of the cooperative learning model with the use of visualization media by students and teachers is included in the very good category, so it can be said that the stages of the learning process have been carried out. So that the research results in the form of the final value of science process skills and mastery of the main concepts of vibration and waves can be used to determine the effect of cooperative learning models by using visualization media.

Science Process Skills

Science process skills were measured using multiple choice scores consisting of 10 questions. The average value of the initial value of the experimental class students is 35 and the control class students are 35 from the ideal value. This shows that the average score of the students' initial scores in the two classes is the same. From these results it can be concluded that in general the initial abilities of students in the two classes before the learning process were not different. Furthermore, based on the data acquisition, the average final score for the experimental class was 71 from the ideal value, while the average final score for the control class was 60, from the ideal value. The N-gain gain for the experimental class 71 is in the high category and the control class 68 is in the medium category. The percentage of achievement of the average value of science process skills initial grades, final grades, and N-gain between the experimental class and control class is shown in Figure 1.

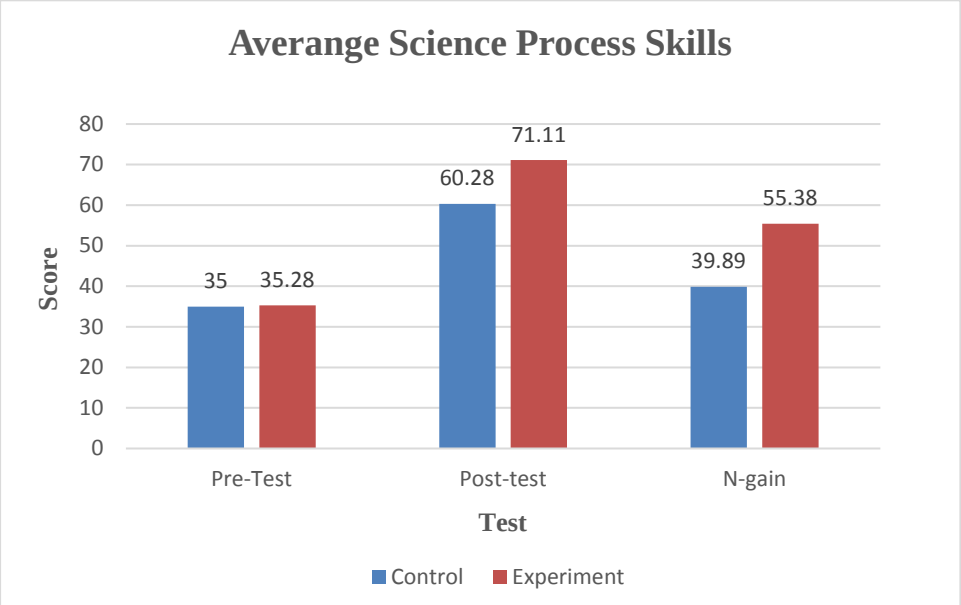

Figure 1. Comparison of the average value of science process skills initial grades, final grades and N-gain in the experimental class and control class

The normality test of the distribution of data on science process skills of students with the subject of vibration and waves in the experimental and control classes was carried out using SPSS 22. Then, the normality test was carried out on the N-gain of science process skills in both classes, obtaining a significance value for the experimental class of 0.200 and the control class of 0.116. This can be seen in Table 2.

Table 2. Normality Value of Science Process Skills Control and Experiment class

Class origin	Kolmogorov-Smirnov			Information
	Statistik	Df	Sig	
Control	0,132	36	0,116	Normal control class N-gain data distribution
Experiment	0,119	36	0,200	Normal experimental class N-gain data distribution

Table 2, it can be seen that based on the normality test of the data distribution using SPSS 22 in the experimental class, p-value was obtained from 0.200 > 0.05, then the data in the experimental class was normally distributed. Furthermore, the normality test for the control class with a significance level of 0.05 obtained p-value 0.116 > 0.05, so that the data in the control class is also normally distributed. Test the homogeneity of the data variance of science process skills of experimental class and control class students using Levene's score (Value of Homogeneity of Variances). Based on the homogeneity test of the average gain normalized using SPSS 22, the p-value 0.131 > 0.05 for the degrees of freedom df1 = 1 and df2 = 78 with a confidence level of 0.95. It can be concluded that the two classes have homogeneous variance. Recapitulation of the average N-gain homogeneity test for the experimental class and the control class.

The results of data testing using SPSS 22 obtained N-gain data on normal and homogeneous science process skills, then the next step used parametric statistics (t test with = 0.05). By using SPSS 22 Independent Sample Value, the result is t_{count} = 3.752 and seen from the table the value of t_{Table} = 2.816 based on the number of 36 students. The value of tcount is much higher than the value of t_{Table}. Based on the results of the t-test, it can be concluded that the investigation group cooperative learning assisted by visualization media can significantly improve students' science process skills compared to cooperative learning without the aid of visualization media.

There is a higher increase in science process skills in the experimental class compared to the control class due to the application of visualization media, because the visualization media trains various indicators on science process skills. The Indianator trained was carried out in the form of: Indirect observations through computer simulations to observe the effect of heat on changes in temperature and state of matter, symbolic language is trained through visualization media and discussion activities in solving problems related to phenomena and the application of heat material in everyday life, logical inference is trained through computer simulation observation activities on visualization media and discussion activities in answering questions and making conclusions in

solving problems given through LKS, mathematical modeling is trained in completing practice questions.

The results showed that the experimental class increased science process skills higher than the control class, this was because the experimental class that used the application of visualization media in cooperative learning made a lot of observations and simulations through visualization media and held discussions in solving various problems related to the application of concepts. and phenomena of heat matter in everyday life. Thus, indirect observation, symbolic language, logical inference, and mathematical modeling are trained, so that this can improve students' science process skills.

In addition to the application of visualization media in the experimental class, the high final score of the experimental class is also supported by cooperative learning which gives students the opportunity to help each other in constructing knowledge and jointly seek solutions to problems. Gleason *et al*., (2011); Leonard, M.M. *et al*., (2019) states that placing students in small groups to get information/tutorials and inviting students to discuss the information will increase students' understanding. Likewise, the opinion expressed by Febianti, (2014); Tullis & Goldstone, (2020) which states that peer teaching is more effective than teacher teaching. Teaching by peers provides an opportunity for students to learn something well at the same time, it becomes a resource for others.

The findings in the study showed that there was a very significant increase in students' science process skills. This is in accordance with the research of Brame, (2016) which shows that visualization media can instill new abilities and skills for students, and can also support teacher assignments effectively. This is in line with research by Chang *et al*.,(2019) which shows that visualization media is also useful in supporting student learning effectively. Herodotou *et al*., (2019) through their research state that visualization skills can also help students understand phenomena and problem solving through generalizations from well-documented observations, so as to improve students' science process skills and mastery of concepts.

Improved Concept Mastery

The improvement of students' science process skills is in line with the increase in their mastery of concepts. Testing the effectiveness of cooperative learning to see the results of mastery of concepts is done by comparing the average value of N-gain between the experimental class that uses the use of visualization media in cooperative learning of the Investigation Group type and the control class that does not use the use of visualization media in the cooperative learning of the Investigation Group type.

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The average value of the initial score of the control class students is 36 while the average value of the initial value of the experimental class students is 36 from the ideal value. This shows that the average value of the initial scores of students in the two samples is the same. From these results it can be concluded that in general the initial abilities of students in the two classes before the learning process were not different. Furthermore, based on the data acquisition, the average final score for the experimental class was 79 from the ideal value, while the average final score for the control class was 54 from the ideal value. The N-gain gain for the experimental class 67 is in the medium category and the control class 29 is in the low category. The percentage of achievement of the average initial value, final score, and N-gain between the experimental class and the control class is given in Figure 2.

The normality test of the distribution of data on the learning outcomes of mastery of the subject matter of vibrations and waves in the experimental and control classes was carried out using SPSS 22. Then, a normality test was performed on the N-gain learning outcomes of mastery of the concepts of both classes, the significance value for the experimental class was 0.155 and the control class was 0.129. This can be seen in Table 3.

Test of homogeneity of variance of data mastery of the concept of mastery of vibrations and waves of experimental class and control class students using Levene's score (Value of Homogeneity of Variances). Based on the homogeneity test of the normalized gain using SPSS 22, the p-value of 0.233 > 0.05 was obtained for the degrees of freedom df1=1 and df2=72 with a confidence level of 0.95.

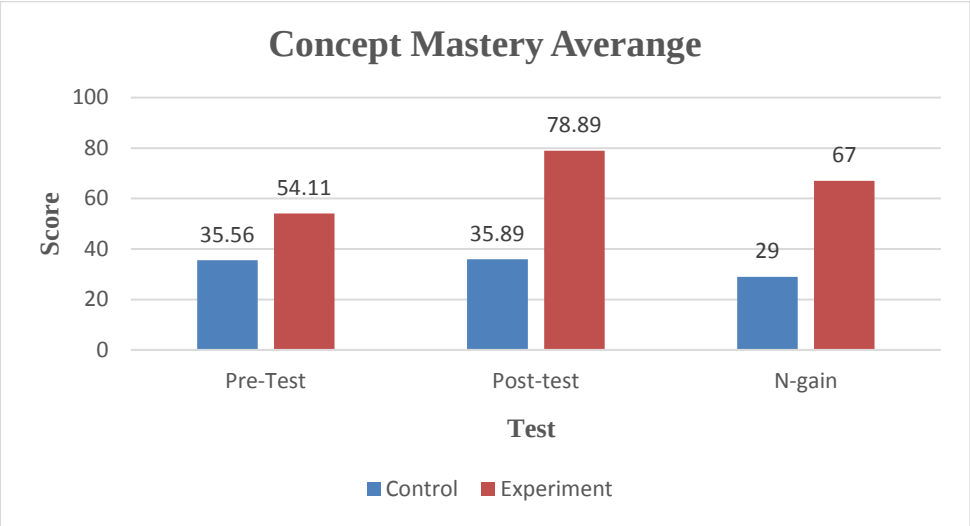

Figure 2. Comparison of the percentage of the average value of learning outcomes mastery of the concept of initial grades, final grades and N-gain in the experimental class and control class.

Table 3 Value of Normality of Learning Outcomes Mastery of concepts

Class origin	Kolmogorov-Smirnov			Information
	Statistik	Df	Sig	
Control	0,948	36	0,129	Normal control class N-gain data distribution
Experiment	0,961	36	0,155	Normal experimental class N-gain data distribution

T test for Improved Concept Mastery Test

The results of data testing using SPSS 22 obtained N-gain data on normal and homogeneous concept mastery learning outcomes, then the next step was to use parametric statistics (t test with = 0.05). By using SPSS 22 Independent Sample Value, the result is tcount = 11.750 and seen from the table the value of tTable = 1,684 based the number of 36 students. The tcount value is much higher than the tTable value. Based on the results of the t-test, it can be concluded that the use of visualization media in cooperative learning of the investigative group type can significantly improve students' conceptual mastery compared to the cooperative learning of the investigative group type without the use of visualization media.

Based on the results of observations on the implementation of the process of using visualization media in cooperative learning of the investigative group type, it plays a very important role in an interactive and communicative learning atmosphere. This can be seen during the learning process, where students are very enthusiastic and have high enthusiasm in carrying out the stages in learning. During the activity in groups, the teacher only acts as a mediator and facilitator.In line with the opinion of Smetana & Bell, (2012) which states that visualization media has limitations so that in this case the teacher plays an important role to assist students in practicing the application of concepts in problem solving phenomena experienced by students through the development of student worksheets that can practice the application of concepts.

The results of the initial value of learning mastery of concepts on the subject of vibration and waves, it is known that the average value of the experimental class is not much different from the control class. So, it can be concluded that both classes have the same initial ability in the science process. Furthermore, based on the final score on the learning outcomes of mastery of concepts, the students who received the Investigation Group cooperative learning model with the use of visualization media as a whole showed better results than the control class who received the Investigative Group cooperative learning

without the application of visualization media. This is indicated by the difference in the average final score and N-gain of the two classes.

The normalized N-gain value for each indicator of concept mastery learning outcomes based on the experimental class students' concept mastery ability indicators was higher than the control class. This shows that cooperative learning learning with the type of Investigation Group assisted by visualization media can help students improve their understanding. Mathai & Ramadas, (2009) argue that the main function of visualization media is to provide easy understanding of students in difficult content. Guan *et al*., (2018) stated that visualization media has limitations so that in this case the teacher plays an important role in helping students overcome the difficulties of applying concepts in phenomena experienced by students through discussion activities.

Student Responses to the Application of Visualization Media in Cooperative Learning Types of Investigation Group.

Student responses to the application of visualization media in learning were captured through an attitude scale. 82% of the students' responses stated that the subject of vibrations and waves was easier to understand after following the lesson with the application of visualization media. Students' opinions regarding the interest in the visualization media display, 92% stated that the visualization media display was very interesting. Based on the average student responses on all indicators of 86%, it can be concluded that most students agree that the application of visualization media in cooperative learning is very fun, provides convenience in understanding the material, and is very interesting.

Furthermore, based on the final test scores for science process skills, students who received the use of visualization media in cooperative learning of the investigative group type overall showed better results than the control class who received the investigative group type of cooperative learning without the use of visualization media. This is indicated by the difference in the average final test scores and N-gain of the two classes. The high acquisition of final test scores and N-gain scores for the experimental class is due to the use of visualization media in learning to train students' scientific process skills and assist students in solving problems. This is in accordance with the results of research conducted by Rutten *et al*., (2012); Simanjuntak *et al*., (2021) which showed that the use of visualization media in the form of computer simulations can improve higher-order thinking and problem solving skills and encourage an increase in students' creativity.

The application of visualization media in applied learning is able to develop several aspects of the ability to manage teacher learning and foster student interest in learning. Students who make observations and simulations

through visualization media in the learning process can encourage the development of thinking skills. However, the teacher has an important role in directing students' attention and increasing the meaningful integration between students' prior knowledge and the new knowledge they acquire. Overall, it can be obtained that cooperative learning of the investigative group type with the use of visualization media can contribute to the objectives of science learning. The results of the research on the aspects under study show that this learning model is effective in improving students' mastery of concepts and science process skills. Furthermore, this model is very perspective to be implemented considering the good student response or responses, arouse student learning motivation, and can maximize.

CONCLUSION

Based on the data and analysis of the results of research it can be concluded that of the research can be seen that the use of visual media material vibrations and waves in cooperative learning investigative group type can improve skills, mastery of concepts and motivate students to be active in learning compared with investigative group type cooperative learning without the use of visual media.

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