



The Effectiveness of Visual Media Human Coordination System to Improve Students' Metacognition and Concept Mastery on Learning with Group Investigation Model

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Article Info

Article History :

Received : August 2023

Approved : August 2023

Published : August 2023

Keywords:

visual media of human coordination system, Group Investigation, metacognition, concept mastery

A abstract

This study aims to determine the effectiveness of visual media human coordination system to improve students' metacognition and concept mastery in learning with the group investigation model. The research was carried out at SMA Negeri 1 Ungaran for the academic year 2021/2022. The research method used is an experimental research method with quasi-experimental type two group pretest-posttest with control design. Sampling was done by purposive sampling. Class XI MIPA 5 as the experimental group used the visual media human coordination system in learning with the GI model and class XI MIPA 6 as the control group used video and PPT in learning with the GI model. The effectiveness of the visual media human coordination system in learning with the Group Investigation (GI) model to improve metacognition ability was determined from hypothesis testing, there was a significant difference in metacognitive ability between the experimental class and the control class. The effectiveness of the visual media human coordination system in learning with the Group Investigation (GI) model to improve students' conceptual mastery skills is determined by the criteria, 1) Achievement of KKM, 2) Obtaining N-Gain, and 3) There are significant differences in the results of students' concept mastery between the experimental class and control class. The results of the metacognitive ability hypothesis test showed that there was no significant difference in the metacognitive ability of the experimental class and the control class. The results of the concept mastery ability showed that the experimental and control class classical mastery > 75% with the increase in students' classical mastery in the experimental class which was higher than the control class. The results of the N-gain test showed that the students' mastery of concepts in the experimental class had reached the criteria. The results of the hypothesis test showed that there was a significant difference in the mastery of the concept of the experimental class and the control class. The conclusion of this study is that the visual media of the human coordination system in learning with the GI model is effective in increasing the ability to master concepts but is not effective in increasing students' metacognitive abilities.

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p-ISSN 2252-6579
e-ISSN 2540-833X

INTRODUCTION

Welcoming the 21st century, the Indonesian Minister of Education Nadiem Makarim issued a new policy, namely the Minimum Ability Assessment (AKM) (Aisah et al., 2021). The AKM questions are made not only to measure certain topics or content but also to integrate various content, various contexts and at various levels of cognitive processes (Mendikbud, 2020). Therefore, students' conceptual mastery skills are needed in depth and also the ability to regulate students' cognitive (metacognition) to meet the demands of AKM. The results of interviews with high school biology teachers in class XI, it is known that the Biology learning process is teacher centered learning by using presentations and giving individual assignments. The media used are videos from YouTube and learning modules. The evaluation results show that not all students can master the material concepts, especially the human coordination system material. This can be seen from student learning outcomes in the human coordination system material, only 40% of students who score above the KKM, while the other 60% have not reached the KKM. The students' mastery of concepts is not yet optimal due to inappropriate learning models and media. Therefore, researchers feel the need to conduct research to improve students' mastery of concepts and metacognitive abilities in the human coordination system material.

Mastery of concepts is a student's ability in cognitive domains related to memory, understanding, application, analysis, evaluation and creation (Anderson & Krathwohl, 2001). Students are said to master the concept if the student really understands the material they are learning so that they are able to explain according to their knowledge without changing the meaning in the material (Awal, Sitti, et al., 2014; Laili et al., 2018). Metacognition relates to students' thinking about their own thinking processes and how they control and adjust their behavior (Anggo, 2011). If the mastery of concepts and students' metacognitive ability is high, it can improve students' ability to process learning information, assist students in solving problems related to misconceptions and learning errors and can improve student learning outcomes (Saputri et al., 2019).

Improving students' metacognitive abilities and mastery of concepts can be done using the right learning model. This is in line with Listiana et al. (2016) which shows that the right learning model has a significant effect in improving students' conceptual understanding and metacognitive abilities. One of the appropriate learning models to improve students' conceptual mastery and metacognition skills is the Group Investigation (GI) cooperative learning model.

According to Danial (2010) the Group Investigation (GI) learning model is a cooperative learning model that can improve students' metacognition and conceptual understanding. Sources of material that can be used in the learning process of human coordination system materials are visual media. The material of the human coordination system studies processes in the body that cannot be observed directly, so it requires learning media that can illustrate these processes. Visual media are concrete objects made to assist students in developing and instilling the concepts of the material being studied (Pramudjono; Rostina, 2013; Pranata, 2016). This 3-dimensional visual media is made to resemble the processes that occur in the body so it can help students understand the concept of human coordination system material. The use of visual media as a source of material in the planning and investigation process in the Group Investigation (GI) learning model is expected to improve students' metacognition skills and mastery of concepts in the human coordination system material.

The results of research conducted by Budiman & Marianti (2020) reported that the application of the Group Investigation (GI) learning model proved effective in improving students' metacognitive abilities with a correlation coefficient of 0.495. In addition, Aini et al. (2018) suggests that the application of the Group Investigation (GI) model in learning can increase mastery of concepts seen from student learning outcomes.

Based on the description above, it is necessary to conduct research related to the Effectiveness of the Visual Media Human Coordination System to Improve Metacognition Ability and Concept Mastery of High School Students in Learning with the Group Investigation Model. This research aims to determine the effectiveness of visual media human coordination system to improve students' metacognition and concept mastery in learning with the group investigation model.

RESEARCH METHODS

This research was conducted at SMA N 1 Ungaran in the academic year 2021/2022. The research method used is an experimental research method with quasi-experimental type two group pretest-posttest with control design. Sampling was done by purposive sampling and used two research subjects, students of class XI MIPA 5 as the experimental group using the visual media human coordination system in learning with the GI model and class XI MIPA 6 as a control group using video and PPT in learning with the GI model. The data used in this study are data on students' metacognitive abilities and mastery of concepts. Metacognition ability was measured using Metacognition Awareness Inventory (MAI), metacognitive ability description test questions, and student learning activity journals. Concept mastery ability is measured by using multiple choice pretest and posttest questions. Student response data was taken to determine student responses to the visual media human coordination system in learning using the GI model. Data on the results of metacognitive ability tests, MAI and student learning journals were analyzed using quantitative descriptive analysis and hypothesis testing. Data from the results of the pretest - posttest were analyzed using classical completeness test, N-gain test and hypothesis testing. Student response data were analyzed using qualitative descriptive analysis. The effectiveness of the visual media human coordination system to improve metacognitive ability in learning with the GI model is determined from the significant difference in metacognitive ability between the experimental class and the control class. The effectiveness of the human coordination system demonstration media to improve the ability to master concepts in learning with the GI model is determined from 1) Achievement of KKM, 75% of students get a score of 75, 2) Achievement of N-gain in the medium category, and 3) There is a significant difference in concept mastery ability between experimental class and control class.

RESULTS AND DISCUSSION

Research result

This study was used to test the effectiveness of the visual media human coordination system to improve students' metacognition and concept mastery in learning the Group Investigation (GI) model. Metacognitive ability data were obtained from MAI results, metacognition test questions and study journals. Concept mastery ability data was obtained from the results of the pretest and posttest questions.

The MAI used in this study was adapted from Schraw and Dennison which was then adapted to the material of the human coordination system. The percentage of MAI result categories can be seen in Figure 1.

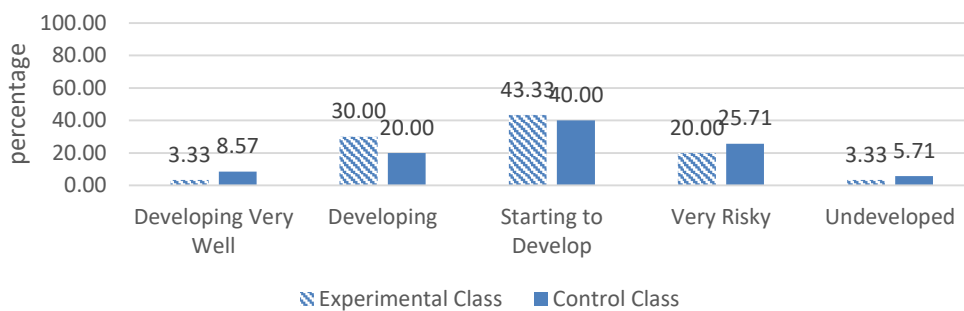


Figure 1 Percentage of Student MAI Results Category

Figure 1 shows the metacognitive ability of students in the category from developing to developing very well in the experimental class of 76.66 % and in the control class of 68.57%. The percentage of the category from developing to developing very well was higher for the experimental class. The MAI results in Figure 1 are a combination of the two aspects of knowledge metacognition and regulation of metacognition. The score for each aspect can be seen in table 1.

Table 1 Average Score of Metacognitive Ability Aspects

Metacognitive aspects	Average Experiment Class	Average Control Class
Declarative Knowledge	75.17	73.29
Procedural Knowledge	75.21	75.89
Conditional Knowledge	75.00	74.86
Metacognitive knowledge	75.00	74.59
Planning	70.28	70.48
Information management strategy	67.83	65.29
comperhension monitoring	76.67	74.71
Debugging strategy	76.50	78.57
Evaluation	74.17	72.71
Metacognitive regulation	72.98	72.27
Metacognitive ability score	73.73	73.09

Table 1 shows the score of metacognitive ability in the experimental class and in the control class which is included in the category of starting to develop. However, the experimental class had a higher average both on knowledge of metacognition and on regulation of metacognition.

Metacognition ability then measured using metacognitive ability test questions. Metacognition test questions are used to measure students' metacognitive knowledge. The average score of metacognition in the experimental and control classes is in the good category with a score of 78.33 in the experimental class and 77.78 in the control class. The percentage of categories of metacognition test results can be seen in Figure 2.

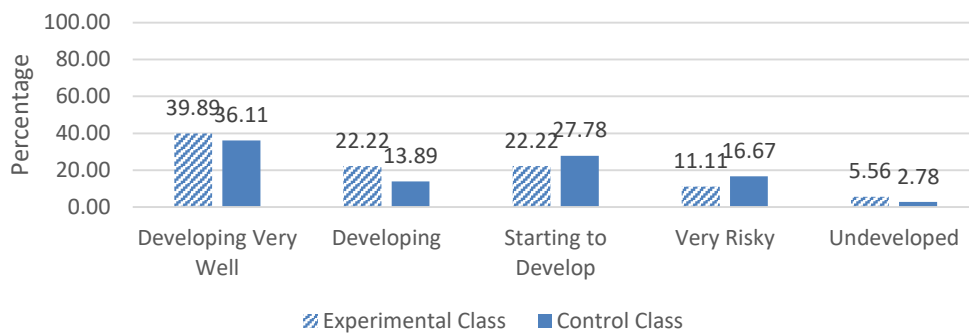


Figure 2 Percentage of Students' Metacognitive Ability Test Result Category

Figure 2 shows the results of the metacognitive ability of students in the category from developing to developing very well in the experimental class, which is higher than the control class with a percentage of 84.33% in the experimental class and 77.78% in the control class. However, the percentage of students' metacognitive abilities in the undeveloped category in the experimental class was also higher than in the control class.

Metacognitive ability was also measured using a study journal to determine students' metacognitive thinking strategies. From filling in student learning journals, the percentage of student learning journal results categories is obtained as follows.

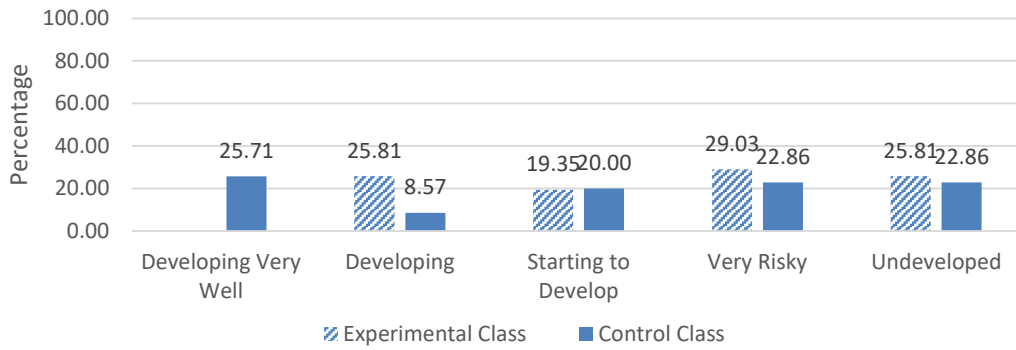


Figure 3 Percentage of Student Learning Journal Results Category

Figure 3 shows that 54.28% of students in the control class fall into the category of starting to develop to developing very well, while in the experimental class there are no students who are in the very good category and only 45.16% of students who fall into the category of starting to develop until well developed. The average score of metacognition as measured by learning journals in the experimental class was 69.96 which was included in the very risky category while in the control class was 71.79 which was included in the category of starting to develop.

The results of metacognitive ability as measured by using MAI, metacognition test questions, and learning journals showed scores that were not much different between the experimental class and the control class. Therefore, a hypothesis test was conducted to determine whether there was a significant difference in the metacognitive abilities of the experimental and control classes. The results of the hypothesis test showed that there was no significant difference in the metacognitive abilities of the experimental class and the control class.

The students' conceptual mastery ability was measured using pretest and posttest questions. The effectiveness of students' concept mastery data was analyzed using three indicators: 1) KKM achievement where 75% of students scored 75, 2) N-gain was in the medium category, 3) There was a significant difference in the concept mastery ability of the experimental class and the control class.

Table 2 Results of Descriptive Analysis of Student Concept Mastery on Human Coordination System Material

Data	Experiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Average value	69.26	81.94	80.28	81.11
Number of students	34	36	36	36
Number of students passing the KKM	20	30	29	33
Classical completeness	58.82%	83.33%	80.56%	91.67%

Table 2 shows that the classical completeness in the experimental class and control class after learning has reached 75%. However, there are differences in the improvement of students' classical mastery before and after learning. The increase in students' classical mastery before and after learning in the experimental class and control class can be seen in Figure 4 below.

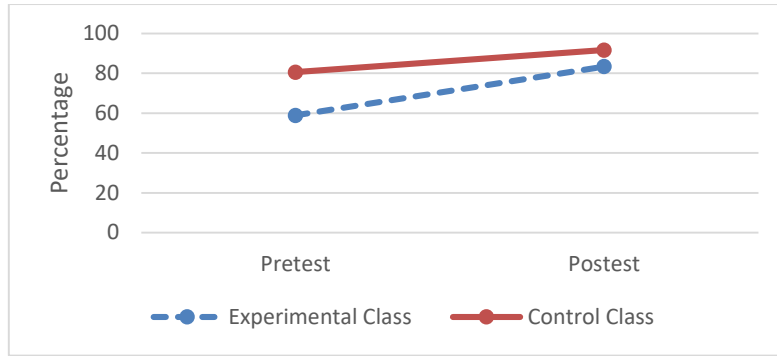


Figure 4 The Improvement of Students' Classical Completeness Before and After Learning

Figure 4 shows the increase in students' classical mastery before and after learning in the experimental class is higher than the control class. The increase in students' classical mastery before and after learning in the experimental class was 24.51 % and in the control class was 11.11%.

Hypothesis testing was conducted to determine whether there was a significant difference in concept mastery between the experimental class and the control class. The results of the hypothesis test showed that there was a significant difference between the difference in students' conceptual mastery in the experimental class and the control class.

The N-gain test was conducted to determine the average increase in students' conceptual mastery abilities. The average N-gain in the experimental class is 0.34 which is included in the medium category, while the control class is -0.26 which is included in the low category. The percentage of the N-gain category in the control class and the experimental class can be seen in Figure 5.

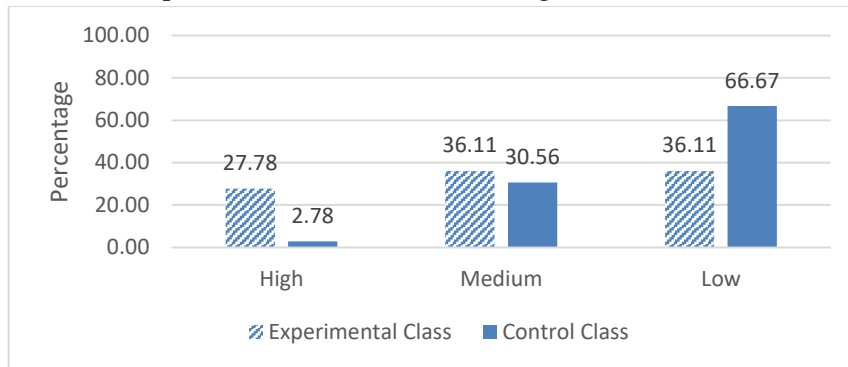


Figure 5 Percentage of N-gain Kategori Category

Figure 5 shows that 63.89% of students in the experimental class are in the medium and high categories, while in the control class only 33.34% of students have N-gain in the medium and high categories.

Student responses to the visual media coordination system in learning with the Group Investigation model were analyzed descriptively quantitatively. This student response questionnaire consists of five statements and two questions related to students' opinions on the visual media human coordination system. The results of student responses can be seen in Tables 3 and 4

Table 3 Results of the analysis of Student Responses to the Visual Media Coordination System in Learning with the Group Investigation Model

No.	Statement	Average Value (%)	Criteria
1	Visual media of the human coordination system in learning with the Group Investigation model makes learning interesting.	86.67	Well
2	I become more focused when using the visual media human coordination system in learning with the Group Investigation model	76.67	Enough
3	The use of visual media human coordination system in learning with the Group Investigation model	79.17	Enough

	motivates me to participate in learning		
4	The use of visual media of the human coordination system in learning with the Group Investigation model makes it easier for me to find material concepts independently.	80.00	Enough
5	Human coordination system visual media are able to explain the material of the human coordination system as a whole	70.83	Not good
Average		78.67	Enough

Table 3 shows that the average student gave a fairly good response to the learning media of the coordination system in learning with the Group Investigation model. However, in statement number 5, namely the visual media of the human coordination system, it is able to explain the overall coordination system material which is included in the not good category. Data on student opinions on the human coordination system visual media can be seen in Table 4.

Table 4 Results of Student Opinion Analysis on Human Coordination System Visual Media

Question Points	Student feedback	Percentage of Students (%)
Student Opinion Against Media Coordination System	The visual media of the coordination system is incomplete and needs to be added to the description of its parts.	33.33
	The use of visual media is complicated and requires a lot of time to prepare.	6.67
	The media is good.	16.67
	There is nothing to improve from the visual media.	26.67
	Students do not give any opinion.	16.67

Discussion

Metacognition is a person's ability to process his own cognition. Metacognition is also defined as knowledge about cognitive processes and how students regulate cognitive knowledge to solve problems. Metacognition abilities possessed by students can facilitate students' understanding when learning (Amin & Adiansyah, 2020). Metacognition ability in this study was measured using three instruments, namely MAI, metacognition test questions, and learning journals.

Metacognition ability as measured by MAI shows that the percentage of students who get the category from developing to developing very well in the experimental class is higher than the control class. The average score of the metacognitive knowledge aspect as measured using MAI in the experimental class was higher than the control class both in metacognitive knowledge and in metacognition regulation. Overall the average score of the experimental class's metacognitive ability is higher than the control class but the range of scores is not much different. This shows that the learning process using visual media in learning with the GI model can improve students' metacognitive abilities. During the learning process students investigate the topic of the problem in groups. Learning carried out in groups can improve students' metacognitive abilities (Listiana et al., 2016). After the investigation, students presented the results of the investigation using the human coordination system visual media. This process encourages students to be able to design effective strategies so that their knowledge can be easily understood. Students design how to explain the results of their investigations using visual media. Muhasidin et al. (2022) states that metacognitive abilities can be realized if someone has been able to design, monitor and assess what they learn.

The students' metacognitive ability which was measured using metacognition test items showed that the average score in the experimental class and control class was in the good category with an average score that was not much different between the experimental class and the control class. The percentage of categories from developing to developing very well in the experimental class was higher than the control class. However, the percentage of students' metacognitive abilities in the undeveloped category in the experimental class was also higher than the control class. This shows that the visual media of the human coordination system in learning with the GI model is not effective in increasing students' metacognitive abilities. The results of interviews with students stated that learning using visual media gave students an overview of the physiological coordination system material. However, the visual media have not fully explained the overall coordination system material (Table 3). Edgar Dale in Cone Dale states that learning with visual media can indeed activate more students' sensory channels so that it increases students' understanding of the material by 90% compared to using video which is only 30% (Davis & Summers, 2015). However, visual media have limitations in the context of the material. Visual media have not been able to represent complex material concepts that can be explained through video. Adinugraha (2018) in his research states that only part of the material that can be conveyed through visual media and there is some complicated material that cannot be explained through visual media. Learning videos can explain the material of the human coordination system as a whole. In addition, Noviyanto et al. (2015) stated that learning videos can explain complex and complex material concepts to be simpler so that they are easy to understand. This is one of the factors that the visual media cannot develop metacognitive abilities to the fullest.

The students' metacognitive ability which was measured using the learning journal category began to develop and developed well, showing a higher percentage in the control class compared to the experimental class. In addition, in the experimental class there were no students who obtained the very well developed category. The average score of metacognitive ability in the control class is higher than the experimental class. Metacognition ability scores measured using learning journals are still very risky, this is due to several factors, one of which is the learning process is carried out when Face-to-face Learning (PTM) is limited, so that the process of student investigation of problems and materials using visual media has not been maximized. The process of presenting the results of the investigation must be adapted to the limited hours of study. Wicaksono et al. (2017) stated that the application of the GI learning model in the learning process takes a long time because students are required to investigate and solve problems. This causes the level of metacognitive ability as measured by using learning journals is still in the very risky category. In addition, the provision of a learning journal that is carried out once after learning at the end of the human coordination system material has not been able to train students to know their own learning progress. Sadikin et al. (2016) stated that the application of assessment learning using learning journals can improve students' metacognitive abilities. Learning journals should be done by students after each lesson, so that they can train students to know the development of learning and their metacognitive abilities in every meeting.

The results of the metacognitive ability hypothesis test as measured using MAI, metacognition test questions and student learning journals did not show a significant difference in metacognitive ability between the experimental class and the control class. Based on the results of the analysis of metacognitive abilities, it can be concluded that the visual media of the human coordination system in learning with the GI model is not effective in improving students' metacognitive abilities. The same result was obtained by AR Wicaksono et al. (2015) which states that the application of GI in learning has no significant effect on students' metacognitive abilities. In addition to knowing the effectiveness of the visual media human coordination system to improve metacognition abilities, this study was also conducted to determine the effectiveness of the visual media human coordination system in learning with the GI model in improving students' conceptual mastery skills.

Concept mastery ability is the ability of students to understand the concepts of the material after the learning process. The ability to master the concept of students is not only the ability of students to understand the material but also its application in solving problems. This study uses the GI learning model in which students are asked to solve problems in the human coordination system by conducting group investigations. The results of the investigation are presented using visual media. Previous research conducted by Yuliono & Rintayati (2018) stated that learning using visual media can improve students' mastery of concepts. The same thing was stated by Cahyo et al. (2019) that learning using the Carnot machine visual media can improve student learning outcomes in physics learning.

The students' conceptual mastery ability is seen from classical completeness after learning has reached 75% both in the experimental class and in the control class. This shows that learning with the GI model can improve students' conceptual mastery skills. Suhartono et al. (2019) in his research stated that there was an increase in students' mastery of science concepts in learning using the GI model. In line with that, Aini et al. (2018) stated that learning using the GI model can improve the ability to master concepts seen from student learning outcomes. The initial knowledge of the control class is higher than that of the experimental class. High initial knowledge will affect students' mastery of final concepts (Salim & Hidayati, 2020). This can be seen from the classical mastery after learning in the control class is higher than the experimental class. However, the increase in mastery of concepts before and after learning in the experimental class was higher than the control class.

The graph of increasing classical mastery before and after learning shows a more significant increase in the experimental class than in the control class. The results of the hypothesis test also show a significant difference between the difference in the concept mastery of the experimental class and the control class. From the classical completeness data of students, it can be concluded that learning by using visual media of the human coordination system is more effective in increasing students' conceptual mastery ability on the material of the human coordination system compared to using video and PPT. Learning using visual media, gives students the opportunity to manipulate the visual media of the human coordination system. The results of the

student response questionnaire in Table 3 state that learning by using visual media makes the learning process more interesting. This is in line with Arsy et al. (2019) states that learning using interesting media can help students focus more on the learning process so that students' mastery of the concept of the material also increases. In addition, Bruner & Olson (1974) in their learning theory said that learning through various symbolic systems such as visual media can provide an overview and strengthen the knowledge that students already have.

The concept mastery ability which was analyzed using N-gain showed that the average N-gain of the experimental class was included in the medium category. While the control class is included in the low category. The percentage of N-gain results in the medium and high categories in the experimental class was higher than the control class. The difference in increasing the ability to master this concept is because learning the material on the human coordination system in the experimental class using visual media in learning with the Group Investigation (GI) model can provide a more meaningful learning experience. Learning is said to be meaningful when students actively participate in the learning process. The learning of the human coordination system material in this study was carried out by group investigation and the use of visual media to present the results of the investigation. Learning activities carried out in groups make the learning process more meaningful (Vallori, 2014). This meaningful learning process helps students gain a deeper understanding of the material (Huang & Chiu, 2015).

The final result of the research shows that the application of the visual media human coordination system in learning with the Group Investigation (GI) model is effective in increasing mastery of concepts but is not effective in increasing students' metacognitive abilities. This is influenced by several factors. Based on the results of student responses in Table 3, learning with visual media does attract students' attention, the use of visual media also increases student focus and motivation and makes it easier for students to find material concepts with good enough categories. However, the visual media human coordination system has not been able to explain the overall coordination system material, this can be seen in statement number 5 table 3 which is included in the not good category. In addition, based on Table 4 as many as 33.3 % are of the opinion that the visual media for the human coordination system is incomplete and needs to be added to the description of its parts. The visual media have not been able to display the structure of the physiological coordination system material. Other influencing factors are, 1) the initial condition of the sample which is not normally distributed, this can be seen from the initial ability of the control class which is higher than the experimental class. 2) Giving a learning journal which is only done once at the end of the learning of the coordination system material has not been able to train students' metacognitive abilities. 3) Limited learning time in the midst of Face-to-face Learning (PTM) is limited with student opinions stating that the use of visual media requires a longer time in the preparation process (Table 4), causing the learning process to use visual media cannot be carried out optimally.

CONCLUSION

Based on the results of the research and discussion of research results, it can be concluded that the human coordination system demonstration media in learning with the Group Investigation (GI) model is effective in increasing students' conceptual mastery skills, but is not effective in increasing students' metacognitive abilities.

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