PILLAR OF PHYSICS EDUCATION
Vol. 15 (3), 2022, page.156-163
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

META ANALYSIS OF THE EFFECT OF THE COOPERATIVE TYPE INVESTIGATION GROUP MODEL ON STUDENT'S COMPETENCE IN PHYSICS LEARNING

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ABSTRACT

Education is one of the foundations in advancing a nation and state. Various efforts in improving the quality of education are by choosing the right learning model. The investigation group model is very actively used to improve learning because it can provide more learning control than other learning models. This study aims to determine the effect size of the influence of the investigation group type cooperative model on student competence in physics learning based on class level, subject matter units, and student competencies. This study will use analysis research method by analyzing the results of previous research from 22 articles. This meta-analysis research method will use effect size analysis techniques.The results of this effect size calculation will be interpreted to answer the hypothesis of the gap in the results of the relevant research. The results of the study revealed that the application of the group investigation (gi) type cooperative model had an effective effect on the class X and XI levels. The application of the Investigation Group type cooperative model also has an effective effect on four units of Physics learning materials, namely quantity and measurement, mechanics, fluids, and electricity. However, the application of this investigation group type cooperative model has no effective effect on the units of temperature and heat matter. Finally, the application of this Investigation Group type cooperative model has proven effective in increasing student competence in the cognitive, affective, and psychomotor realms.

Keywords : *Meta Analysis; Effect Size; Cooperative Type Investigation Group Model; Physics Learning*

I. INTRODUCTION

Education is one of the foundations in advancing a nation and state. The better the quality of education in a country, the better the quality of society and the nation. Based on Law No. 20 of 2003 article 3 concerning the National Education System, the purpose of national education is to develop the potential of students to become human beings who have faith and piety in God Almighty, have a noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens to face a better future .

Various efforts in improving the quality of education, including by improving the curriculum, developing learning tools, improving educational facilities and infrastructure, improving the quality of teachers, improving learning outcomes, developing a student learning outcome assessment system, and so on. Improving the quality of education requires improving the teaching and learning process. This improvement in the teaching and learning process will produce students who have the desired quality.

The goverment has made efforts to improve the quality of education, one of them by improving the implementation of learning process in schools based on contructivism learning theory through Education Unit Level Curriculum (KTSP) [1]. Efforts to improve the quality of education is marked by the renewal of the education system from time to time, one of which is through curriculum renewal. The learning process that

develops in the classroom is generally determined by the role of teachers and students as individuals directly involved in the process [2].

The real conditions obtained after conducting the analysis indicate a gap between the real condition in the field and the ideal condition. The first real condition found was that the learning model implemented in schools was still conventional which resulted in students feeling bored[3][4][5][6]; Teacher-centered conventional learning in which the teacher has a dominant role in every learning process[7][8][9][10]. The learning method used is still the lecture and assignment method[11][12][13] as a result, students become unenthusiastic during the learning process[14].

The second real condition found is that the learning outcomes of students are still low because students think that physics is difficult so that the desire to take physics lessons tends to decrease[15]. Students' conceptual knowledge is also low because there are several indicators that conceptual knowledge has not been achieved[13]. Students only memorize concepts so that they are less able to use them if they encounter problems that exist in everyday life[6] and to change students' views from e rroneous concepts to scientific concepts is also usually quite difficult[16].

The gap that occurs between real conditions and ideal conditions requires a solution that is able to overcome the gap. The solution to the problems previously presented is to apply a cooperative model of the Investigation Group type in the physics learning process. Various research results show that the application of a investigation group type cooperative model will have an influence on student competence.

This investigation group type of cooperative model was chosen because it is able to improve student competence. Investigation group is a type of cooperative model, students are working in a small group using cooperative inquiry, group discussions, planning and cooperative projects, then students will present their findings throughout the class [17]. Research on learning using a cooperative model of the Investigation Group type has been carried out by many previous researchers. The results of the search conducted by researchers on educational articles related to the influence of the Investigation Group type cooperative model have varied influences that are only limited to one subject matter and one student competence. Based on this reason, a summary is needed that can make it easier to take data sources or be used as a reference for students who want to find the influence of a Investigation Group type cooperative model on student competence using the meta-analysis method.

This meta-analysis research will collect research on relevant topics. This meta-analysis research can answer the question of gaps in the results of various research results. Then the existing data is processed and used to make statistical conclusions. The data can be expressed by various measures (effect size) that are calculated or searched first by formulas expressed in various mathematical equations that are closely related to the purpose of the meta-analysis research carried out. This meta-analysis research can answer the question of gaps in the results of various research results. This meta-analysis research will provide a big picture of the influence of this Investigation Group type cooperative model on its bound variables. Therefore, this study aims to determine the effect size of the influence of the investigation group type cooperative model on student competence in physics learning based on class level, subject matter units, and student competencies.

II. METHOD

The type of research used is meta-analysis research. This meta-analysis method aims to examine research study articles both nationally and internationally. The meta-analysis research method was first pioneered [22]. Meta-analysis is one of the efforts to summarize various research results quantitatively [23]. Meta-analysis uses techniques to summarize various research results quantitatively by looking for effect size values [24]. This study examined 22 articles in international and national journals starting from 2011 to 2020.

The data in this study is a secondary source of data because it is obtained from studies that have been carried out by previous researchers. The data were collected from 22 sample articles based on previous studies. Secondary data sources are data sources that are not directly collected to the data collector [25].

The data collection technique in this study used meta-analysis techniques. The steps in conducting a meta-analysis are: 1) establishing the theme of the research, 2) choosing the type of publication to be collected, 3) collecting research results or literature, 4) recording research data (variables), 5) calculating the size effect per source or research, and 6) interpreting a summary and making a report [24].

In this study, it used a large analysis technique of the influence of the effect size value. The analysis technique uses a quantitative approach through calculation and analysis of the data already in the article to determine the results of the effect size calculation. How to determine the effect size of a study is very diverse, in general we can divide it into :

A. Calculating the effect size of each article

1. The effect size formula for the test of the difference between the two groups of samples is related if it is known only the average value of the experimental group and the average value of the control group and the standard deviation of the control group. Then the size of the effect is determined by the formula below :

$$d = \frac{M_T - M_C}{SD_{within}} \quad (1)$$

2. The effect size formulas for the two independent sample groups for the average value of the posttest-pretest and the standard deviation of the pretest of the experimental class are known, and the standard deviation of the posttest of the known control group is:

$$d = \frac{(M_{postT} - M_{preT}) - (M_{postC} - M_{preC})}{SD_{pre+post}} \quad (3)$$

3. The formula effect size the comparison test of two independent samples for the number of students of the experimental group, the number of students of the control group and the value of tcount known. Then the size of the effect is determined by the formula below:

$$d = \frac{M_T - M_C}{SD_{pooled}} \quad (5)$$

(Source: Ref [17])

B. Calculating the Mean Effect Size

In the meta-analysis calculation we calculate the effect size based on information or research results reported from a number of analyzed studies. Because the information obtained comes from the sample (not the population), the resulting effect size is the effect size observed from the sample (observed effect). However, the actual effect size at the population level (true effect) is of unknown value. Therefore, there are two models for calculating the mean effect size in meta-analysis research, namely:

1. Random Effect Model

The Random Effect (RE) model was used when the analyzed study populations differed functionally due to treatment performed by several people[26].These differences can be due to differences in the characteristics of the sample or participants observed, and how the treatment is applied to the sample.

2. Fixed Effect Model

The Fixed Effect (FE) model is used when the analyzed study population meets two conditions. First we believe that all the studies analyzed are functionally identical (equivalent). Second, the purpose of the analysis is to make inferences based solely on the identified population and not to generalize on a broader scale[26].

C. Interpreting the results of the effect size

After the size of the effect is calculated, the value of the size of the effect that has been obtained will then be interpreted according to the categories that have been set as follows:

Table 1. Effect Size Interpretation

Num	Effect Size	Category
1.	ES≤0.15	Negligible
2.	0.15<ES≤0.40	Low
3.	0.40<ES≤0.75	Intermediate
4.	0.75<ES≤1.10	High
5.	ES≥1.10	Very High

(Source: Ref [27])

III. RESULTS AND DISCUSSION

Various articles that was explaining the effect of the cooperative type group investigation models on student's competence have been widely carried out. Researchers will summarize articles related to the influence of this group investigation type cooperative model using the meta-analysis method. This meta-analysis research will be a benchmark to determine the effect size is on the entire article that has been collected. This research is divided into three categories of research, namely class level, subject matter units, and student competencies.

Based on the research that has been carried out, in this chapter will be presented the results of data processing for this meta-analysis research. This study discusses articles with the theme of research on the influence of Investigation Group type cooperative models on student competence in physics learning. Researchers took data contained in 22 articles published from 2011 to 2020. These articles are published nationally as well as internationally.

Once the articles are collected, researchers read each of them to obtain the desired variables. Then calculate the size effect per source and interpret the data. The results of the calculation of the size of the effects of each article are presented in the table, and then calculated the average. The average results of the effect size of each article were analyzed according to the objectives of the study.

A. Research Results

1. Effect Size of Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Grade Level

Grade level is the first category that researchers can analyze. From the analyzed articles there are classes X and XI. It can be seen in the following table 2.

Table 2. Effect Size Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Grade Level

Num	Grade Level	Article Code	*Effect size*	Number of Articles
1.	X	B1	1.130	15
		B3	0.434	
		B4	1.430	
		B5	0.961	
		B6	1.217	
		B7	1.940	
		B8	1.310	
		B9	0.721	
		B10	0.445	
		B13	0.419	
		B14	1.407	
		B16	1.594	
		B18	0.626	
		B21	0.741	
		B22	0.862	
2.	XI	B2	1.737	7
		B11	0.424	
		B12	1.407	
		B15	0.886	
		B17	0.508	
		B19	1.180	
		B20	0.479	

The first result in this study is related to the effect of the effect of the group investigation type cooperative model on student competence in physics learning in terms of class level. The effect size value of each article can be seen in the table above. By using the calculation of the mean effect size with the random effect model, a summary of the results of the mean effect size analysis of the influence of the group investigation type cooperative model on student competence in learning physics class X and XI can be seen in table 3.

Table 3. Data On the Results of the Mean Effect Size Investigation Group Type Cooperative Model on Student Competence in Physics Learning at the Grade Level

Grade Level	N	ES	SE	Category	P	95% Confidence Level	
						Lower	*Upper*
X	15	1.102	0.124	Very High	0.000	0.769	1.255
XI	7	0.926	0.193	High	0.000	0.549	1.304

Based on the results of the analysis using the RE model, the mean effect size of the influence of the Investigation Group type cooperative model in physics learning in class X was 1.106 with Z-calculate 8.167 and Z-table which was 1.960. The results of the analysis for the mean effect size influence of the Investigation Group type cooperative model model on student competence in physics learning in class XI, namely 0.926 with Z-calculate 4.807 and Z-table which is 1.960. The results of hypothesis testing for both levels of the class showed that the hypothesis was accepted because the calculated Z obtained was greater than the Z of the table. So it can be concluded that in the cooperative model this type of Investigation Group is effectively applied to classes X and XI.

2. Effect Size of Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Subject Matter Units

The subject matter is the second category to find the influence of the Investigation Group type cooperative model on student competence in physics learning as shown in table 4 below.

Table 4. Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Subject Matter Units

Num	Subject Matter Units	Article Code	*Effect Size*	Number of Articles
1.	Quantity and Measurement	B8	1.310	2
		B14	1.407	
2.	Mechanics	B3	0.434	11
		B5	0.961	
		B7	2.076	
		B10	0.478	
		B11	0.424	
		B13	0.419	
		B15	0.886	
		B16	1.594	
		B17	0.508	
		B18	0.614	
		B21	0.741	
3.	Fluid	B2	0.091	4
		B6	1.217	
		B12	1.407	
		B19	1.180	
4.	Temperature and Heat	B4	1.430	3
		B20	0.479	
		B22	0.862	
5.	Electricity	B1	1.130	2
		B9	0.721	

The second result in this study is related to the effect of the effect of the group investigation type cooperative model on student competence in learning physics in terms of subject matter units. To determine the mean effect size based on the unit of subject matter using the random effect (RE) and fixed effect (FE) models which can be seen in the table below.

Table 5. Data On The Results Of Mean Effect Size Investigation Group Type Cooperative Model On Student Competence In Physics Learning Based On Subject Matter Units

Subject Matter Units	N	ES	SE	Category	P	95% Confidence Interval	
						Lower	*Upper*
Quantity and Measurement	2	1.349	0.199	Very High	0.000	0.958	1.739
Mechanics	11	0.830	0.167	High	0.000	0.503	1.157
Fluid	4	1.007	0.124	High	0.000	0.764	1.250
Temperature and Heat	3	0.591	0.316	Intermediate	0.061	-0.028	1.211
Electricity	2	0.971	0.204	High	0.000	0.516	1.317

Based on the results of the analysis using the RE and FE models, the mean effect size of the influence of the Investigation Group type cooperative model on student competence in learning physics in each subject unit was obtained. The results of hypothesis testing for magnitude and measurement matter, mechanics, fluids, and electricity show that the hypothesis was accepted because the Z of the calculated obtained was greater than the Z of the table . As for hypothesis testing on temperature and heat matter shows that the hypothesis is rejected because the obtained calculated Z is smaller than Z of the table.

3. Effect Size of Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Student Competence

Student competence is the third category to find the influence of a Investigation Group type cooperative model on student competence in physics learning can be seen in table 6 below:

Table 6. Effect Size Effect of Investigation Group Type Cooperative Model on Student Competence in Physics Learning Based on Student Competence

Num	Student Competencies	Article Code	*Effect Size*	Number of Articles
1.	Cognitive	B1	1.130	15
		B2	1.737	
		B3	0.434	
		B4	1.430	
		B5	0.961	
		B6	1.217	
		B9	0.721	
		B11	0.424	
		B12	1.407	
		B13	0.419	
		B14	1.407	
		B15	0.886	
		B18	0.626	
		B21	0.741	
		B22	0.862	
2.	Affective	B7	1.940	4
		B10	0.445	
		B16	1.594	
		B19	1.180	
3.	Psychomotor	B8	1.310	3
		B17	0.508	
		B20	0.479	

The third result in this study is related to the effect of the effect of the Investigation Group type cooperative model on student competence in physics learning in terms of student competence. To determine the mean effect size based on student competence using the random effect (RE) and fixed effect (FE) models. The summary of the results of the mean effect size analysis of the influence of the Investigation Group type cooperative model on student competence in physics learning in terms of student competence can be seen in table 7.

Table 7. Data On The Results Of Mean Effect Size Investigation Group Type Cooperative Model On Student Competencies In Physics Learning Based On Student Competencies

Student Competencies	N	ES	SE	Category	P	95% Confidence Interval	
						Lower	*Upper*
Cognitive	15	0.957	0.110	High	0.000	0.741	1.172
Affective	4	1.258	0.304	Very High	0.000	0.689	1.880
Psychomotor	3	1.071	0.242	High	0.000	0.597	1.545

Based on the results of the analysis using the RE and FE models, the mean effect size of the influence of the Investigation Group type cooperative model was obtained on student competence in physics learning in each student competency. The results of hypothesis testing for cognitive, affective, and psychomotor show that the hypothesis was accepted because Z calculate is greater than Z table.

B. Discussion

Various studies on the effect of the Cooperative type Investigation model on student's competence in physics learning have been widely carried out. To find out the effect of this learning model, the researcher has calculated the effect size which is then analyzed and mapped to draw conclusions about the effect of the learning model in effect size. This study aims to see the effect of the cooperative type Investigation Group model on student's competence using the meta-analysis method.

The results of this study were carried out based on three indicators, namely the level of educational units, units of subject matter, and student competencies. From the 22 articles that have been analyzed, both national and

international articles, the results of the study obtained that the Investigation Group type cooperative model affects students' competence in learning physics.

The first result obtained was the influence of a Investigation Group type cooperative model on student competence in physics learning based on grade level. Based on the results of hypothesis testing, the Investigation Group type cooperative model has a very high influence on student competence in learning Physics in class X and has a high effect on class XI. Based on hypothesis testing at the level of classes X and XI obtained Z calculate is larger than Z table. So it can be concluded that the cooperative model of Investigation Group type is effectively applied at the level of classes X and XI.

The second result obtained is the influence of a Investigation Group type cooperative model on student competence based on the unit of subject matter. The application of this Investigation Group type cooperative model is effectively used in magnitude and measurement materials, mechanics, fluids, and electricity. The effect size of the very high category is found in the material of magnitude and measurement and in the units of mechanical, fluid, and electrical materials are in the high category. As for temperature and heat materials, the Investigation Group type cooperative model is not effective to apply. This is due to the fact that Z calculate is smaller than Z table on hypothesis testing for temperature and heat matter.

The third result obtained is the influence of a Investigation Group type cooperative model on student competence in physics learning based on student competence. From the results of the calculation of the mean effect size, a very high category is obtained in the affective realm. Meanwhile, the affective and psychomotor realms are in the high category. After hypothesis testing was obtained for all three realms of student competence it was obtained that Z calculate was greater than Z table. This shows that this GI-type cooperative model is effectively applied to improve student competence in the cognitive, affective, and psychomotor realms.

Then, Group investigation learning is very actively used to improve learning because it can provide more learning control than other learning models [18]. Group investigation model requires students to have a good ability to communicate, improve student's learning achievement, and group process skills [19]. The group investigation learning model involves students in the planning stage of both topic being studied and how the investigation progresses and emphasizes the partification and activities of students to find information that supports the subject matter to be learned through available materials [20]. Cooperative learning in questions is considered appropriate to be applied in the learning process because it can improve student's scentific working skills [21].

IV. CONCLUSION

The application of this Investigation Group type cooperative model has proven to be effectively applied to classes X and XI. Then, the application of a Investigation Group type cooperative model also proved effective for 4 units of subject matter, namely quantity and measurement, mechanics, fluid, and electricity and ineffective in temperature and heat subject matter units. Finally, the application of this Investigation Group type cooperative model is also effectively applied to improve student competence in the cognitive, affective, and psychomotor realms.

ACKNOWLEDGMENT

With the completion of this article, I would like to express my deep gratitude to the Department of Physics, Padang State University, Physics lecturers, and other relevant parties. Hopefully, this article can provide benefits to every reader.

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