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META ANALYSIS OF THE INFLUENCE OF INQUIRY LEARNING MODEL ON STUDENT LEARNING OUTCOMES IN PHYSICS

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ABSTRACT

Education is an effective means to improve the quality of human resources. As a reference for the implementation of national education, the curriculum is an important factor that influences the learning process. One of the educational standards that becomes a reference in learning is the competency of graduates. The model that can improve learning outcomes is the inquiry learning model. This study aims to determine the effect size summary of the influence of the inquiry learning model on physics learning outcomes in high school and junior high school science based on education level and subject matter. This type of research is a meta-analysis. The research was conducted by summarizing, reviewing and analyzing data from 34 articles that had been done previously. The data analysis techniques used are 1) Determining the effect size, 2) Determining the summary effect size, and 3) Testing the null hypothesis. From the results of data analysis carried out, it can be concluded that the results of the study, namely 1) Summary of effect size The effect of the inquiry learning model on learning outcomes at the high school level is greater than at the junior high school level. This can be seen from the value of each summary effect size, namely at the high school level of 0.43 and at the junior high school level of 0.35. This means that inquiry learning is more influential at the high school level. 2) *Summary of effect size The effect of the inquiry learning model on learning outcomes is the highest on the subject matter, namely the measurement of 1.19 and the lowest on the business and energy material of 0.18. This means that inquiry learning affects the measurement material. .*

Keywords :*Meta analysis; inquiry; student learning outcome; effect size.*

I. INTRODUCTION

One indicator of the quality of human resources is the level of education. Education is one of the important areas in the development of each Country.Through education students are given provisions that can provide experience to advance their lives so that they can develop in accordance with the progress of the times. Education is an effective means to improve the quality of people's well-being, and is able to deliver the nation to prosperity. The quality of education describes the quality of human resources.

Good graduate competence can be achieved by using the right learning model in the teaching and learning process. The use of appropriate learning models can help teachers to a more effective learning and teaching process as well as improve student competence. Learning models are structured based on various principles or theories of knowledge. The most widely used model in learning one of them is the inquiry learning model.

Inquiry is a learning model that prepares learners in situations to conduct their own experiments extensively, to see what is happening, want to do something, ask questions, and look for the answers themselves, and connect one discovery with another, comparing what is found with what other learners find. [1]

The inquiry model is a model that essentially engages students into the original problem and confronts them with an investigation, helps identify conceptual or problem-solving methods contained in the investigation, and directs students to find a way out of the problem. [2]

The learning model of the learning inquiry emphasizes more on the student's thought process so that students are able to independently solve problems than in question [3]. This means that the learning process of this inquiry is a learning activity in the thought process, so that in this case there will be a reciprocal relationship between teachers and students to identify a problem solution and encourage students to be able to identify the problem independently.

The ability of students in finding the answers in question will familiarize students to continue thinking in the learning process. In addition, this inquiry learning model will also make students become more active and train students in using their reasoning thinking and encourage students to dare to make their arguments. This of course will slowly change the learning style of students who previously only received information from teachers. However, in the process of implementing the inquiry learning model students who think more and are accustomed to be able to independently find answers from questionable things in the learning process.

Science learning is one of the 2013 curriculum implementation models. Science is a learning process that is known as the scientific process. Science learning is essentially a learning approach that allows students to actively seek, explore and discover concepts and principles learned independently, meaningfully and actively. Science as a systematic and formulated knowledge that deals with the symptoms of materiality and is based primarily on observations. Therefore, the expected learning conditions can encourage students in seeking information from various sources[4].

Learning physics is meaningful learning, in the sense that every concept learned by students must truly understand before reaching students to exercises whose applications are to everyday life. But in reality that occurs in the field, in understanding the material is not uncommon for students who experience difficulties. This happens because the learning process tends to memorize materials and formulas without trying to understand and understand further the material. Students are also rarely actively involved in group activities so that students become saturated. These problems have an impact on the low learning outcomes of students.

Students who succeed in learning are successful in achieving learning goals or instructional goals[5]. Learning outcomes are changes that result in people changing their attitudes and behaviors[6]. Learning outcomes concern cognitive, affective, and psychomotor aspects [7].

This research was conducted to look at the influence of inquiry learning models on learning outcomes in Physics and Science subjects. Physics and science subjects are applied to the level of junior high school education and upper secondary schools. In the study of Physics, the subject matter taught is related to everyday objects and events. In physical materials there are uniqueness such as temperature, electricity, effort and energy that are found in everyday life but can not always be considered directly by students.

Search results on related national and international journals, the need for a summary of research results that discuss various research problems with the learning model used. In this study, researchers wanted to conduct a meta-analysis of the influence of inquiry learning models on learning outcomes. With this meta-analysis, it is expected that the results of the study can be better. Meta-analyses may also be conducted on various observational studies to produce conclusions from combining research results[8]. Meta-analysis has several objectives, including increasing statistical power for primary research results, to obtain an estimate of the effect size, namely the strength of the relationship or the magnitude of differences between variables, and overcome the uncertainty or controversy of some research results [9]. Meta-analysis has several objectives, including increasing statistical power for primary research results, to obtain an estimate of the effect size, namely the strength of the relationship or the magnitude of differences between variables, and to overcome the uncertainty or controversy of some research results [10].

Meta-analysis was chosen as the research method based on several considerations, namely: there are significant differences in the relationship between variables in various studies containing the same research variables, experimental research cannot be carried out in many classes by the school, especially in various schools spread across Indonesia. In several places, meta-analysis research is able to conclude the influence of various existing experimental studies, meta-analysis research does not depend on school conditions, thereby reducing the risk of research delays due to non-conducive school conditions, There has been no comprehensive study of the *effect size* of the use of inquiry learning models on student learning outcomes in the subjects of Physics in Senior high school and junior high school. Therefore, meta-analysis is a very appropriate research method to conclude various research results in a broad scope. This research has the achievement, it is necessary to determine the research objectives, as follows 1) To find out the summary *effect size* of the influence of the inquiry learning model on

student learning outcomes when viewed based on education level. 2) To find out the summary *effect size* of the influence of the inquiry learning model on student learning outcomes when viewed based on the subject matter.

II. METHOD

Meta-analysis was employed as a research method in this study. Meta-analysis is a sort of research that involves summarizing, analysing, and evaluating data from previous studies. The meta-analysis include research that is quantitative because it calculates it with numbers and statistics from many data sources [11]. Meta-analysis is a quantitative study to process or analyze several research results using statistical methods to summarize and obtain general conclusions [12]. Meta-analysis is one type of review which is a form of identifying, evaluating and interpreting all relevant studies for a specific research question, or a particular topic area or phenomenon of interest to the researcher [13]. The collection of research data was carried out by browsing articles in online journals through the University E-Journal Web, Sinta, Proceedings of the National Seminar, and Google Scholar.

This research design consists of three stages. The first stage is the preparation stage where the researcher determines the domain based on the independent variable, the dependent variable, and the moderator variable. After that, the researchers set the research criteria based on the form of publication and year of publication. Furthermore, the researchers set the operating definition of the dependent variable, for example, the increase in student learning outcomes in physics learning obtained by students, both pre-test and post-test, which was expressed in the form of scores. The next stage is the implementation stage where at this stage the researcher begins to search for and collect the articles obtained and then the researchers divide them into several criteria, which include education level, learning model, and region. Data analysis is the final step. The researcher examines the effect size based on the target factors and methodological variables at this step. Then the researchers group the articles with effect sizes of low, medium, high, and very high. After that, they make a summary in a scientific report.

This study has three variables, namely independent, bound, and moderator. The independent variable for this research is learning video, while the dependent variable is student learning outcomes. The moderator variables for this research are education level, learning model at high school level, and region.

This study uses a meta-analysis method that was conducted on 26 articles related to the effect of using videos published in 2014-2021. The analytical technique used is a quantitative approach with calculations and data analysis in the article. To facilitate data analysis, data tabulation was carried out with the following steps: (1) Identifying the variables found, (2) Identifying the experimental and control groups' mean and standard deviation(3) Calculating the effect size with the following equation.

$$\mathrm{ES} = \frac{(\bar{\mathrm{X}}_{\mathrm{post}} - \bar{\mathrm{X}}_{\mathrm{pre}})\mathrm{E} - (\bar{\mathrm{X}}_{\mathrm{post}} - \bar{\mathrm{X}}_{\mathrm{pre}})\mathrm{C}}{\frac{\mathrm{SD}_{\mathrm{pre}}\mathrm{C} + \mathrm{SD}_{\mathrm{pre}}\mathrm{E} + \mathrm{SD}_{\mathrm{post}}\mathrm{C}}{3}} \qquad (1)$$

After finding the effect size results based on the above formula, effect size criteria can be seen in Table 1.

Table 1. Interpretation of Effect Size

ES	Category
ES ≤ 0,15	Very Low
0,15 < ES ≤ 0,40	Low
0,40 < ES ≤ 0,75	Medium
0,75 < ES ≤ 1,10	High
ES > 1,10	Very High

(Source: Ref [14])

Based on Table 1, the value *effect size* with a small effect size of 0.15 can be ignored while the effect size from 0.15 to 0.40 is included in the low category. The effect size from 0.40 to 0.75 belongs to the medium category. The effect size from 0.75 to 1.10 is included in the high category. And a large effect size of 1.10 includes a very high effect criterion.

The other formulas to find the *effect size* are as follows:

1. Average in one group

$$ES = \frac{\bar{X}_{post} - \bar{X}_{pre}}{S\,D_{pre}} \qquad (2)$$

2. Average in each group

$$ES = \frac{\bar{X}_E - \bar{X}_C}{S\,D_C} \quad (3)$$

3. If the standard deviation is not known then it can be done by t test

$$ES = \frac{t}{\sqrt{2n}} \quad (4)$$

After interpreting various research studies, it will be known how the effect of using video on learning outcomes in high school physics and junior high school science subjects based on education level, learning model, and region by calculating Effect Size using the described formula.

III. RESULTS AND DISCUSSION

A. Research result

The acquired effect size of the research sample was which was divided based on two factors, namely education level and subject matter, based on the results of the analysis conducted on 34 articles.

1. *Effect size* Inquiry Learning Model on Learning Outcomes Based on Education Level

The first results in this study related to the influence of the inquiry learning model based on the level of education. The average value of effect size based on the level of education is obtained from the calculation of the effect size of each article. The average effect size based on the level of education used from 34 articles can be considered in the Table below

Table 2. The Summary Effect Size For The Education Level

Education Level	Article Code	Effect Size	Number Of Article
Junior High School	A19	0,42	13
	A20	0,37	
	A21	0,31	
	A22	0,15	
	A23	0,14	
	A24	0,16	
	A25	0,22	
	A26	1	
	A27	0,43	
	A28	1,04	
	A32	0,20	
	A33	0,29	
	A34	0,16	
Senior High School	A1	0,88	21
	A2	0,50	
	A3	0,21	
	A4	0,23	
	A5	0,30	
	A6	0,37	
	A7	0,34	
	A8	0,20	
	A9	1,43	
	A10	0,57	
	A11	0,87	
	A12	0,33	
	A13	0,46	
	A14	0,72	
	A15	0,58	
	A16	0,48	

A17	0,20
A18	0,34
A29	0,15
A30	0,25
A31	1,25

Based on the data in table 3, the effect size based on education level is presented where there are 13 articles at the junior high school level and 21 articles at the high school level.

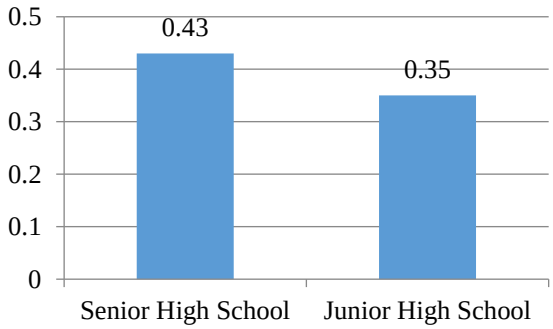

Fig 1. Summary Effect Size Graph by Education Level

Based on the table above, it is known that the use of the inquiry learning model has an effect on the high school level with a summary effect size of 0.43 compared to the junior high school level which has a summary effect size 0.35. More details can be seen in the graph below.

2. Effect size Inquiry Learning Model On Student Learning Outcomes Based on Subject Matter

Table 2. Effect Size Model Of Inquiry Learning on Learning Outcomes Based on Subject Matter

Subject Matter	Article Code	Effect Size
Fluida	A1	0,88
	A12	0,33
	A13	0,46
	A27	0,43
Elasticity and Hooke's Law	A2	0,50
	A9	1,43
Business and Energy	A4	0,23
	A20	0,37
	A23	0,14
Motion	A3	0,21
	A5	0,30
	A11	0,87
	A28	1,04
Temperatur and Heat	A6	0,37
	A7	0,34
	A15	0,58
	A16	0,48
	A17	0,20
	A18	0,34
Dynamic Electricity	A8	0,20
	A29	0,15
Measurement	A10	0,57
	A30	0,25

Wave Vibration	A19	0,42
	A25	0,22
	A26	0,81
Momentum and Impuls	A14	0,72
	A30	0,25
Enviromental Pollution	A21	0,31
	A33	
Ecosystem	A22	0,15
	A32	0,20
Motion System	A24	0,16
	A34	1,6

Summary Effect size of the Inquiry Learning Model on Student Learning Outcomes by Subject Matter

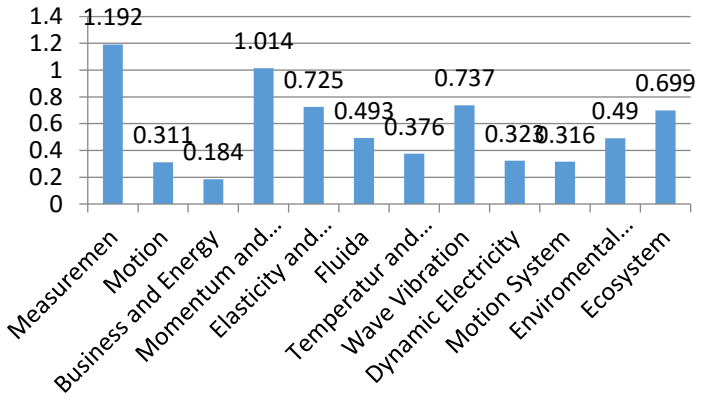

Fig 2. Summary Effect Size Graph by Subject Matter

The subject matter in question is material that includes science subject matter for junior high school and high school physics. Based on the table, it can be seen that the use of the inquiry learning model has an influence on the measurement material with a summary effect size of 1.192 with a very high category and gives the least effect on the business and energy material with a summary effect size of 0.184 classified as a category that can be ignored, more clearly it can be seen in the graph. below this.

B. Discussion

The first results achieved were the indicators of the inquiry learning model on student learning outcomes based on the level of education in junior high and junior high schools. The level of education that has the largest effect size value is the high school level with an effect magnitude of 0.43 with moderate criteria. Meanwhile, for the junior high school level, the magnitude of the effect obtained is 0.35 with medium criteria. Based on these results, it can be seen that the use of the inquiry learning model at the high school level is higher than the junior high education level. Seeing the results of the effect size on the use of inquiry learning models based on education level, it can be interpreted that the use of inquiry learning models has an effect on the learning process. This indicates that the inquiry learning model can be used at every level of education, but is more influential at the high school level[15]. The inquiry learning model is more influential at the high school level, because junior high school students are not used to learning to find, seek and students' independence is still low.

The second result achieved is an indicator of the inquiry learning model on student learning outcomes based on the subject matter, the subject matter that has the largest effect size is the measurement material with an effect magnitude of 1.192 with very high criteria. As for the subject matter that has a low effect size, namely the business and energy material with an effect magnitude of 0.184 with low criteria. Based on these results, it can be seen that the use of the inquiry learning model in the subject matter that is more influential is the measurement subject matter. Learning material is more meaningful if students understand the subject matter related to the context of real life[16]. The inquiry learning model can train students to use their reasoning to solve a problem and relate the material being taught to problems with everyday life.

The inquiry model is a model that essentially involves students in the original problem and confronts them with an investigation, helps identify conceptual or problem solving methods contained in the investigation, and directs students to find a way out of the problem. the problem[17]. The inquiry model is a series of learning activities that emphasize the process of thinking critically and analytically to seek and find the answer to a problem in question. The thought process itself is usually carried out through questions and answers between teachers and students.

IV. CONCLUSION

Summary effect size The influence of the inquiry learning model on learning outcomes at the high school level is greater than at the junior high school level. It can be seen from the value of each summary effect size, namely at the high school level of 0.43 and at the junior high school level of 0.35. This means that inquiry learning is more influential at the high school level.Summary effect size of the influence of the inquiry learning model on learning outcomes is the highest on the subject matter, namely the measurement of 1.19 and the lowest on the material of work and energy of 0.18. This means that inquiry learning has an influence on the measurement material. The limitation of this research is that it only covers 34 articles, which consist of 2 international articles and 32 international articles. This study only obtained 21 articles with physics subject matter and 13 more covered natural science material due to the lack of articles on physics subjects that were equipped with the standard deviation needed in calculating the effect size.

REFERENCES

[1] L. E. Rahmawati, P. Octaviani, H. Kusmanto, Y. Nasucha, And M. Huda, "The Accuracy Of Complex-Procedures Texts Material In Bahasa Indonesia Textbook For The First Grade Of Senior High School," *Asian Journal Of University Education* , Vol. 17, No. 1, Pp. 91-99, 2021.

[2] Siboro, A., Tampubolon, R., Tafonao, M., Ndruru, M.S. & Amazihono,M, Pengaruh Model Pembelajaran Inkuiri Berbantuan Project Terhadap Hasil Belajar Fisika Pada Materi Pokok Pengukuran Kelas X Semester I SMAS GKPI Padang Bulan Medan T.P 2020/202. *Jurnal Penelitian Fisikawan*, 4(1), Pp. 14-18, 2021.

[3] H. R. Anjani, S. Y. Sari, Y. Darvina, and L. Dwiridal, The Effect of Hots-Oriented Worksheets on Heat and Kinetic Theory of Gases on Students' Critical and Creative Thinking Ability with Guided Inquiry Model in Grade XI SMA Al-Istiqamah Pasaman Barat, Pillar of Physics Education, vol. 14, no. 1, pp. 74-80, 2021.

[4] A. Indraningrum, W. Sunarno, & N. S. Aminah, "Pengembangan Modul IPA Terpadu Tipe Connected Berbasis Iqra Materi pembelajaran Lingkungan Pantai untuk Memberdayakan Karakter Religius Siswa SMP/MTs Kelas VII Semester II," Inkuiri Artikel Pendidikan IPA, 6(3), 113-126, 2017

[5] R. Linda, Z. Zulfarina, & P.T. Putra, "Peningkatan kemandirian dan hasil belajar peserta didik melalui implementasi e-modul interaktif IPA terpadu tipe connected pada materi energi SMP/MTs," Jurnal Pendidikan Sains Indonesia, 9(2), 191-200, 2021.

[6] H. Noka, Hamdi, Nurhayati, Pengaruh LKS Berorientasi Model Picture and Picture Dalam 163 Pendekatan Contextual Teaching and Learning (CTL) Terhadap Hasil Belajar IPA Siswa Kelas VII SMPN 1 X Koto Singkarak, Pillar Of Physics Education, Vol. 6, pp. 161-168, 2015

[7] D. Yarsina, S. Y. Sari, Y. Darvina, and Asrizal, Kajian Literatur Pengaruh LKS Inkuiri Terbimbing Terhadap Hasil Belajar Fisika Siswa Untuk Berbagai Jenjang Pendidikan, Pillar of Physics Education, vol. 13, no. 3, pp. 467-474, 2020.

[8] A. D. M. Zuler, & Y. Darvina, "Meta-Analysis Of The Effect Of The Use Of Jigsaw Type Cooperative Model On Student Learning Outcomes In Learning Natural Science In Junior High School And Physics In Senior High School," Pillar Of Physics Education, 14(2), 146-152, 2021.

[9] N. P. Tenti, Meta-Analysis of the Effect of Integration Stem Education in a Various Learning Models on Student Physics Learning Outcomes, Pillar of Physics Education, vol. 13, no. 4, pp. 520–528, 2020.

[10] A. Nora, "Meta Analysis of The Influence of Problem Based Learning Models in High School Physics Students on Student Learning Outcomes," Pillar Of Physics Education, 13(4), 494-501, 2021..

[11] Yulia Putri Nasution I, Putra A, Meta Analysis of The Effcet of Student Worksheet Use on Student Learning Outcomes, *Pillar of Physiscs Education* , Vol 14, No. 4, pp. 251-258, 2021

[12] Syahmi Hasya and Yenni Darvina, Meta Analysis of The Effect of The Use of Dodule on Students' Critiscal Thinking Ability in Physics and Science Courses, *Pillar of Physics Education*, Vol.15, No. 2, pp. 139-145, 2022
[13] Azilia D, Darvina Y, Zulfa R, Meta Analysis of The Effect of The Use of Video on Student Learning Outcomes in Physiscs and Science Lessons, *Pillar of Physics Education,* Vol. 15 (2), pp. 100-106, 2022.
[14] Fitri, N. R., & Afrizon, R, Meta Analysis of The Influence of Ict Based Physics Learning Media on The Learning Outcomes of Senior High School Students, *Pillar of Physics Education* 14(4), 274-282, 2022.
[15] R. Sofia , Festiyed, Asrizal, Hufri, Meta Analysis of The Effect of The Discovery Learning Model On Student Learning Outcomes In Physics Learning, *Pillar of Physics Educatio,* Vol 14(4),pp.290-297, 2021.
[16] N. Syahdi, Desnita, Murtiani, and W.S. Dewi, Meta Analysis of The Effect of Use Worksheet On Students Critical and Creative Thinking Skills In Learning Natural Science In Junior High School and Physics In Senior High School, *Pillar of Physics Education,* Vol.14, No.3,pp 235-241, 2021
[17] Z.S. Fitriane, Gusnedi, Desnita, Afrizon, Renol. Creation of Android-Based Mobile Learning Modules Using Guided Inquiry Models For High School Physics Materials, *Pillar of Physics Education,*Vol 15 no. 1, 2022, pp. 31–38.