

META ANALYSIS OF THE EFFECT OF THE USE OF MODULE ON STUDENTS' CRITICAL THINKING ABILITY IN PHYSICS AND SCIENCE COURSES

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ABSTRACT

The twenty-first century is evolving at an incredible rate.. The development of information and communication technology in all aspect of life, including in the learning process has entered the modern era. The ability to think critically and solve problems skill (problem solving skill) are important skills for surviving in the twenty-first century. The real condition found in the field were that students' critical thinking skills are relatively low during the teaching and learning process. One solution to overcoming this problem is to use learning media namely in the form of modules. Then, it is necessary to have further research on the Module. Meta-analysis is the term for this type of study. Researchers undertake meta-analysis by synthesizing research data, examining, and analyzing research data from a number of previously published studies. Conducting a literature review, gathering data, studying and assessing papers, analyzing and interpreting articles, and producing report results are all steps in meta-analysis. The necessary statistical data must be included in the article, according to the standard. From the data analysis carried out, it can be stated three results of this research. First, the use of the module has a significant effect on the senior high school level compared with an average effect of 0.931 to junior high school level. Second, the use of the module has a significant effect on the Newton's Gravity material with an average effect of 3.742. Third, the use of the module has a significant effect by using a Contextual Teaching and Learning Model and saintific approach.

Keywords : Meta Analysis; Module; Critical Thinking Skills; Effect Size; Physics.



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I. INTRODUCTION

Education is important for building a nation that is superior than previous generations.. Education will continue to develop in accordance with the times. In the 21st century, science and technology (IPTEK) are developing very rapidly. Science and technology are used in all sectors of life. Illustrates this. a requirement that a person must meet in the 21st century is to master various skills, one of which is 4C skills. 4C skills consist of critical thinking (critical thinking skills), creativity (creative thinking skills), communication (communication), and collaboration (collaboration) [1].

Critical thinking skills are skills that are able to analyze ideas or ideas to be more detailed and better [2]. Critical thinking skills are often defined as a form of higher-order thinking that involves a variety of skills, including processing, interpretation, analysis, evaluation, inference, explanation and self-regulation [3]. To conclude, critical thinking ability are the ability to study ideas in depth in order to form the valid conclusions.

Critical thinking indicators include analysis, evaluation, inference, deductive thinking and inductive thinking. Analysis indicators are subscales that measure whether students are able to understand and analyze graphic images and paragraphs with various considerations. Evaluation indicators are subscales that measure whether students are able to process information and relate it to conclusions so that they are able to state the results of their own thoughts.[4] The Conclusion indicator is a subscale that measures students' ability to identify information so that they can draw a conclusion. The indicator of deductive thinking is a subscale measuring students' abilities starting from general things to general conclusions. The indicator of inductive thinking is a subscale that measures the ability of students' knowledge to reach general conclusions [5].

To improve students' critical thinking skills at school, action needs to be taken, namely meeting the demands in accordance with the 2013 curriculum, one of which is the use of modules [6]. A module is a teaching practice that contains a unit concept from teaching materials. Module teaching is an individual teaching process that allows students to master one unit of subject matter before moving on to the next unit. So that the concept of learning physics can be accepted by students so that it can help you build critical thinking abilities. The purpose of using the module is to increase efficiency and effectiveness in learning in schools, both in time, funds, facilities, and teachers in achieving a maximum learning goal [7].

Modules that are designed are certainly more effective if learning is well collaborated between sources, models and approaches in a learning process so that it will increase. Problem-based learning, also known as problem-based instruction, is a teaching method that employs real-world situations to teach students critical thinking and problem-solving abilities, as well as subject-specific knowledge and concepts [8]. While the scientific approach is a learning process centered on students to stimulate intellectual development (thinking skills) so that it is appropriate in the implementation of the learning process, it is a learning process designed so that students are able to construct concepts, laws, or principles through observing, formulating problems, formulating hypotheses, collecting data with various techniques, analyzing data, drawing conclusions, and communicating them [9].

The success of teaching and learning activities in schools is the main thing that teachers want in implementing education in schools. The success or failure of students in learning can be seen from the achievement of learning objectives that have been set by the previous teacher. The benchmark for teacher success in teaching in the classroom is the result of students' thinking abilities [10]. This can be seen from what students have achieved in understanding and mastering the concepts and materials that have been taught by the teacher. Learning outcomes are learning achievements achieved by students in learning activities and bring about a change in one's behavior, which is marked by changes in one's attitudes and actions from not knowing to knowing [11].

Physics plays a role in developing the ability to think and imagination to form quality human resources. Understanding, mastery of the material and student achievement are indicators of the success of the physics learning process [12]. In the appearance of the media, the teacher only provides an explanation of the material, causing the learning process that takes place to be dominated by the teacher [13]. So, learning physics is very important because it can foster higher thinking skills, especially critical thinking skills.

Meta-analysis has several objectives, including increasing statistical power for primary research results, to obtain an estimate of effect size, namely the strength of the relationship or the magnitude of the difference between variables and to overcome the uncertainty or controversy of some research results [14]. The advantages of meta-analysis are that it allows the combination of various kinds of research results in a quantitative way, is able to describe the relationship between studies well so that it can overcome differences in results between studies, is more objective because it focuses on data, while other literature reviews focus on conclusions from various meta-analytical studies that focus on effect size, and it is carried out quantitatively so that it is easier to do.

After reviewing several articles, it was found that the reality on the ground was not in accordance with the expected ideal conditions. The real condition found is that students' critical thinking skills are still not optimal because students do not understand the concepts of learning being taught. This is due to the limited availability of instructional media that refers to the 2013 curriculum. Based on the search results of related national and international journals, a summary form of research results is needed that discusses various research problems with the learning media used. In this study, researchers want to see how the effect of using modules on students' critical thinking skills based on education level, subject matter, models and approaches applied in learning?

II. METHOD

This study uses a meta-analysis method. Meta-analysis is research by practicing statistical methods by organizing large amounts of information from large samples with functions to complement other purposes. This meta-analysis research is research that uses secondary data in the form of previous research data, so this research is called research *ex post facto* in the form of surveys and analysis [15]. Meta-analysis is quantitative by using numerical calculations and statistics for practical purposes, namely to collect information from a lot of data that is not possible with other methods.

The process of gathering, identifying, analyzing, classifying, and interpreting different research findings is known as meta-analysis. These studies are typically classified according to the journal in which they were published, sample size, control group, experimental group, type of treatment, length of treatment, and a variety of other factors. Meta-analysis has a number of goals, including enhancing statistical power for primary study findings, estimating effect size (the strength of a relationship or the magnitude of a difference between variables), and overcoming the uncertainty or controversy surrounding some research findings [16].

Effect size is the difference in the incidence of effects between the experimental group and the control group in the meta-analysis. It is a combination of *the effect sizes* of each study carried out with certain statistical

techniques, because in general, the makers of the meta-analysis do not have basic research data, so practically the dimensions of effect sizes that are combined in meta-analyses are the same as those reported in the combined articles. The scale of effect variables on meta-analysis in the medical literature can be nominal, numerical or ordinal [17].

When used as a research method, meta-analysis has several advantages, including that of the skill to quantitatively combine several previous research results, the ability to provide a good overview between studies and the ability to reduce variations in these studies' conclusions, as well as the fact that meta-analysis is quite objective and focused on research data. The meta-analysis approach is quantitative and fairly straightforward to execute, and it is obtained from research publications, whereas the literature review concentrates on the final results from multiple meta-analyses [18].

Weaknesses found in meta-analysis research: This study uses data that already exists in published research, so that meta-analysis is considered unable to describe clearly the results obtained because the research results obtained are more likely to be published than those that are not, drawing the wrong conclusions in the meta-analysis. Analysis occurs because of errors related to its objectives. In conducting the analysis, the researcher should separate the data and statistics that consist of moderator variables obtained in the article [19].

Research variables are everything that has a certain variation that is determined by the researcher to be studied and then drawn conclusions about [20]. In this research, 3 variables have been determined. The three variables are the independent variable, the dependent variable, and the moderator variable.

This study uses a meta-analysis of several articles related to the module. The analysis technique is using a quantitative approach through calculations and data analysis that is already in the article. The number of samples taken using 20 articles related to the use of modules on critical thinking skills from 2015-2021. This article is done by providing tabulation of data in order to make it easier when conducting meta-analysis. The steps for tabulating data are: 1) identifying the type of research and the variables discovered, which are entered into the appropriate variable column 2) identification of the mean and standard deviation of both groups' experimental and control groups for each subject/subject research that has been tested and, 3) calculating effect size using the following statistical parameters

$$ES = \frac{(\bar{X}_{post} - \bar{X}_{pre})_{eksperimen} - (\bar{X}_{post} - \bar{X}_{pre})_{control}}{\left(\frac{SD_{pre\ control} + SD_{pre\ eksperimen} + SD_{post\ control}}{3}\right)} \quad (1)$$

After the *effect size* is calculated based on the appropriate formula, then the *effect size* is categorized by the criteria *effect size* according to *Diancer* as shown in the following Table 1.

Table 1. Interpretation of *Effect Size*

<i>Effect Size</i>	<i>Category</i>
$ES \leq 0,15$	<i>Very Low</i>
$0,15 < ES \leq 0,40$	<i>Low</i>
$0,40 < ES \leq 0,75$	<i>Medium</i>
$0,75 < ES \leq 1,10$	<i>High</i>
$ES > 1,10$	<i>Very High</i>

(Source: Ref [12])

Effect size: with a small effect size of 0.15, the effect 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

$$ES = \frac{\bar{X}_{post} - \bar{X}_{pre}}{SD_{pre}} \quad (2)$$

2. Average in each group

$$ES = \frac{\bar{X}_{eksperimen} - \bar{X}_{control}}{SD_{control}} \quad (3)$$

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

$$ES = t \sqrt{\frac{1}{n_{eksperimen}} + \frac{1}{n_{control}}} \tag{4}$$

it will be known how the effect of using modules on critical thinking skills based on education level, subject matter, models and approaches applied in the learning process by calculating *Effect Size* using the formula that has been described.

III. RESULTS AND DISCUSSION

A. Research Result

Following are the findings of grouping the effect of utilizing the variable-based module on pupils' critical thinking skills and calculating the value effect size of every article while recognizing 20 articles having distinct variables.

The first the outcome of this meta-analysis is about the effect. of using the module on education levels. The figure shows the average value of the effect size based on the amount of education utilized in 20 articles. In the Figure 1.

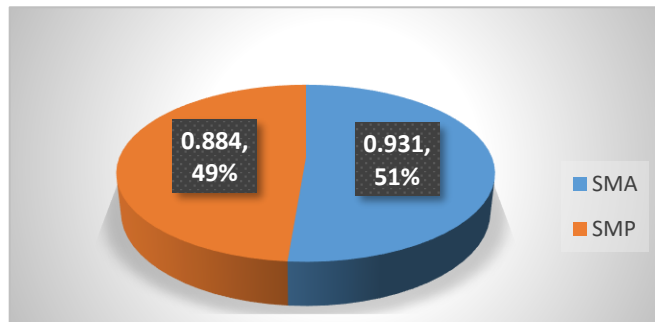


Fig. 1. Graph of the Summary Effect Size Module Effect on Critical Thinking Skills Based on Education Level

The levels of education referred to in this study are the SMA and SMP levels. Based on the picture above, it is known that the use of the module has a greater influence at the high school level, with a summary effect size of 0.931, compared to the junior high school level, which has a summary effect size of 0.884. However, both of them are still in the high category.

The second finding in this meta-analysis is the effect of using the module in terms of learning materials, as determined by the size of each article's effect. The Figure 2 below reveals the average value of the effect size in terms of the learning materials utilized in 20 articles, which is classified into two levels of education, SMP and SMA.

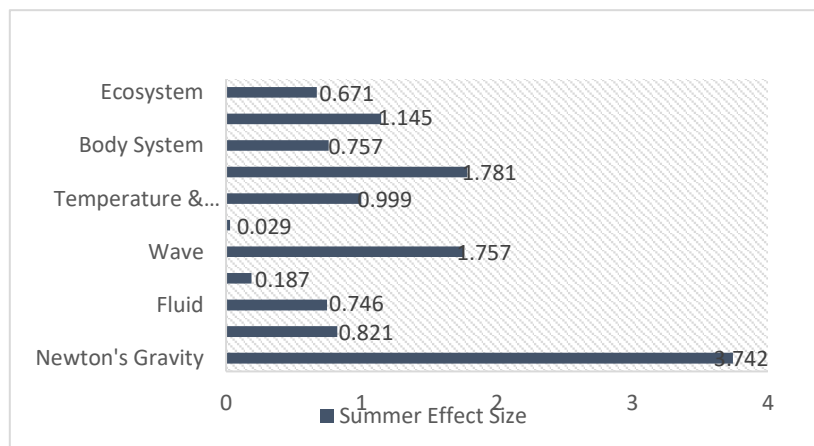


Fig 2. Data on the Summary Effect Size Module Effect on Critical Thinking Skills Based on Subject Matter

The subject matter in question is material that includes high school physics and junior high school science subjects. Based on the figure above, it can be seen that the use of the module has the highest influence on Newton's Gravity material with a summary effect size of 3,742 in the very high category and the smallest effect on the measurement material with a summary effect size of 0.029, which is classified as a very low category.

The results of the analysis related to the effect of using modules on critical thinking skills based on models and approaches, can be seen in Figure 3.

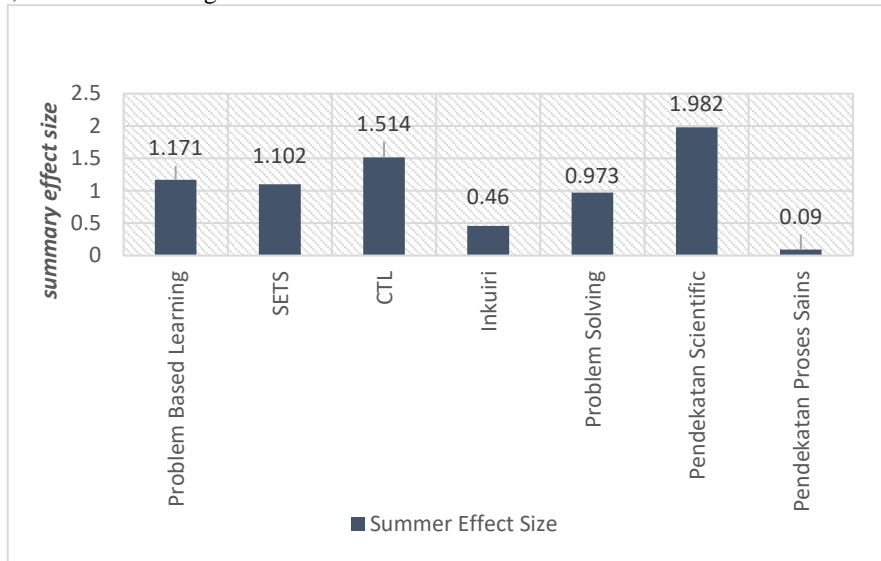


Fig 3. Summary Effect Size Effect of Using Modules on Critical Thinking Skills Based on Models and Approaches

Based on the graphs that have been presented, it can be seen that the CTL learning model has a significant influence on the use of modules with a summary effect size of 1,514, which is classified in the very high category, and also the scientific approach, with a summary effect size of 1,982, which is classified in the very high category.

The results of the analysis related to the effect of using modules on critical thinking skills based on the research area, can be seen in Figure 4.

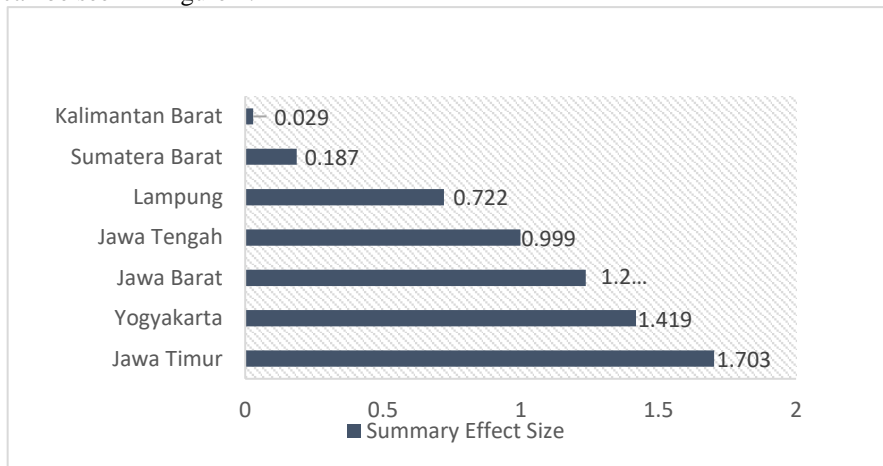


Fig 4. Summary Effect Size of The Effect of The Module on Critical Thinking Skills Based on The Research Area

The research areas in question include East Java, Yogyakarta, West Java, Central Java, Lampung, West Sumatra, and West Kalimantan. Based on the graph presented, it can be seen that the use of the module has a significant impact on the East Java region, with a Summer Effect Size of 1,703, which is classified in the very high category. and has the smallest effect on the West Kalimantan region with a summer effect size of 0.029, which is categorized as very low.

B. Discussion

The first indication research's findings are based on educational levels. The levels of education found in the articles that have been analyzed are SMA and SMP levels. The influence of the highest level of education is SMA compared to SMP level. However, the category results obtained for each level are in the very high category with

a large effect for the high school level of 0.931 and for junior high school students of 0.884. This indicates that the use of learning media in the form of modules can be used at every level of education to achieve good critical thinking skills [21]. The purpose of using the module is to increase efficiency and effectiveness in learning in schools, in terms of time, funds, facilities, and teachers in achieving a maximum learning goal. The module is the smallest unit of the learning program that can be studied alone by students, thus the modules are organized logically with language that children can understand according to their age level of understanding, with minimal aid from educator [6].

The second result is the effect of the module based on the learning material. According to the results of the calculation *effect size*, there are several learning materials that have a very high effect when the module is applied, namely the Newton's Gravity material. This is obtained because the module contains learning materials systematically and integrated in a single unit and connects the material presented with the real life of students, so that students more easily understand the content of the material presented. The module is a means of assisting students in relating the material to everyday life, so that students can easily understand the material taught by the teacher in class.[7]

The third research result is the effect of using the model module and the applied learning approach. According to the results of the calculation *effect size*, the effect of using the module based on the applied learning model and approach gives very high results in the Contextual Teaching and Learning model and the Scientific approach. This shows that the use of modules in learning physics and science based on applied learning is effective in improving students' critical thinking skills. If learning is well collaborated between learning resources and learning models in a learning environment, then the quality of the learning process will increase [22]. CTL, also known as problem-based instruction, is a teaching method that employs real-world situations to teach students critical thinking and problem-solving abilities, as well as subject-specific knowledge and concepts. While the scientific approach is a learning process centered on students to stimulate intellectual development (thinking skills) so that it is appropriate for them observing, establishing problems, formulating hypotheses, gathering data using various methodologies, evaluating data, drawing findings, and communicating to construct concepts, laws, or principles them, the scientific approach is a learning process centered on students to stimulate intellectual development (thinking skills) so that it is relevant for them to construct concepts, laws, or principles through observing, formulating problems, formula [13].

IV. CONCLUSION

From the data analysis carried out, it can be stated that three results can be obtained from this study. First, the use of the module has a very significant effect at the senior high school level with an value of *effect size* 0.931 compared to the high school juniors. Second the utilization of the module has a large impact on high school Newton's Gravity material with an effect size of 3.742 and junior high school photosynthesis material with an effect size of 1.781. Third, the use of modules has a significant impact on model- Contextual Teaching and Learning and scientific approaches to learning.

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