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META-ANALYSIS OF THE APPLICATION OF STEM APPROACH BASED ON HOTS IN PHYSICS SUBJECT ON CRITICAL THINKING SKILLS OF STUDENTS

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ABSTRACT
Various skills that must be mastered by students to be able to prepare themselves to match the human resources of developed countries are today's challenges. One of these skills is critical thinking. The application of the STEM approach is a new era to meet the learning objectives in the 21st century. And by applying the HOTS-based STEM approach will improve students' critical thinking skills. The research in this article uses the meta-analysis method by finding the effect size calculation value of each journal analyzed. Thus, it is found that the learning model that has a major effect on the application of the HOTS-based STEM approach is the experimental learning model, with the material of Electricity *and Magnetism and with the help of simulation media at the XII grade high school level.*

Keywords: STEM Approach, HOTS, Critical Thinking

INTRODUCTION

The revolution that occurred in the 21st century caused various aspects of human life to be closely related to technology, communication and information. This has led to increased competition for labor competencies (Daryanto & Karim, 2017). One aspect that is globally able to compete is education that is directed to be able to develop comprehensive intelligence, namely cognitive abilities and spiritual intelligence, social, emotional and so on. (Muyassarah &et al, 2018). The world's demands in the field of education require great efforts to improve the quality of human resources in Indonesia.

Based on recorded data on the ability of its human resources, Indonesia has actively participated in PISA since 2000. The institution that carries out the task of measuring the level of skills of students throughout the world is PISA, an acronym for the Program for International Student Assessment (PISA. 2015). By following the program, it shows the fact that Indonesia is at the lowest score which shows the low quality of Indonesian education from other countries. Evidently from 72 participating countries, Indonesia in 2016 was ranked 63rd (OECD, 2016). If there is no change or improvement of the problem, the future impact is to continue to print a generation of low-quality nations. President

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Director of IBM Indonesia, Goenawan Susanto, said that foreign graduates who have skills and expertise in technology will be more ogled by global companies than local graduates who have not met company standards.

Furthermore, from the results of the analysis of the data attached by PISA for Indonesia's young generation, namely: The literacy level of students is low, with an overall average of 32%. Also the level of science literacy of Indonesian students is relatively low. As well as the ability to solve problems that are much lower than other Southeast Asian countries such as Malaysia, the Philippines and Thailand. (Permatasari, 2016).

The truth of the data above is supported by one of the results of research by Sumarmo on high school students in Bandung City. Which is where the problem solving ability of class XI high school students is generally still low. Likewise, research conducted by Neni in 2018 at one of the high schools in Bandung showed that students' ability to solve problems was only 30% of the ideal score. In other words, the results of the above studies show that the ability of students to solve problems, especially in physics learning, is still very low.

By applying STEM learning into a priority learning model in solving learning material problems, it can train students' thinking skills in solving global issues and problems facing the world today, for example: air pollution, global warming, clean drinking water, and food security (Reeve, 2015). Thus, graduates with high competence are those who have been significantly influenced by the application of STEM. They have high abilities in problem solving and are more dexterous in completing their work (Khalidi, 2017). However, STEM competencies have not been mastered by many graduates in Indonesia, while the demand for labor with the skills needed in the 21st century is needed in large numbers. (Anggraini & et al, 2017).

Therefore, based on the results of this explanation, a title was compiled to conduct research, namely "Meta-Analysis of the Application of the HOTS-Based STEM Approach to Physics Subjects on Students' Critical Thinking Skills".

METHODS

This research uses meta-analysis research with a quantitative approach. In short, meta-analysis research is a type of survey research that is included in descriptive research, namely the study of several research results in the same type of problem. The quantitative approach is an approach that uses calculations from numbers and statistics for practical purposes, such as compiling and extracting information from a lot of data that is not possible with other methods (Glass, 1981). To obtain data, we searched, collected, and analyzed articles related to STEM Learning Based on HOTS (Higher Order Thinking Skills) of students in Physics. The samples used in this study were 10 journals. The parameters of the effect size calculation value obtained are as shown in the table below:

Table 1. Description of Effect Size parameters according to Cohen (2017)

No.	Effect Size	Category
1.	> 1,00	High
2.	0,51-1,00	Medium
3.	0,21-0,50	Low

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4.	0-0,20	Less

RESULT & DISCUSSION

Due to the journal articles that are used as references to find data in accordance with the title of the article, namely the effect of applying the HOTS-based STEM approach on students' critical thinking skills in physics subjects are 10 journals. The details are in the following table:

Based on the results of the calculation of the effect size of 10 journals regarding the application of the HOTS-based STEM approach to physics material, almost 80% have a significant effect on improving students' critical thinking skills. The next table will explain the grouping based on the learning model used.

Table 2. Ef. Size based on learning model

No.	Learning Model	N	Ef. Size
1.	Blended Learning	1	1,34
2.	Problem Based Learning	2	4,30
3.	Project Based Learning	2	2,90
4.	Experiment	4	10,40
5.	Argument-Driven Inquiry	1	2,39

According to the table above, the learning model that is often used by researchers in the implementation of HOTS-based STEM learning in physics material is the experimental model. The second is the PjBL model that leads students to create a project by improving 4C skills.

Table 3. Effect Size Based on Learning Media

No.	Learning Media	N	Ef. Size
1.	E-Modules	3	5,62
2.	Phet Simulation	2	5,52
3.	LKPD	2	3,82
4.	Simulation	3	5,64

The use of E-Modules and simulation-based media is the media with the highest category. The use of these media is more effective in using HOTS-based STEM approaches to improve students' critical thinking skills in physics material.

Table 4. Effect Size Based on Learning Materials

No.	Material	N Article	ES
1.	Kepler's Laws	1	1,34
2.	IPA	3	2,25
3.	Effort and Energy	1	0,77
4.	Elasticity	1	2,39

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5.	Electricity and Magnetism		3,85
6.	Electroplating	1	3,10
7.	Optics	1	0,72
8.	Thermodynamics	1	2,39

According to the description of the table above, it can be stated that the highest Effect Size value on electricity and magnetism is 3.85.

CONCLUSIONS & RECOMMENDATIONS

Thus it can be concluded that (1) The average effect size obtained from the application of the HOTS-based STEM approach to students' critical thinking skills is 2.06 which falls into the high category. (2) In the application of the STEM approach, the model that supports is an experimental model of 10.40 which involves students to conduct an experiment. (3) And the use of learning media that supports significant changes from the application of the STEM approach is simulation media which is 5.64. (4) The school level and class that has the highest influence on the application of the HOTS-based STEM approach to physics material is SMA in class XII. (5) The last material is Electricity and Magnetism which gets an effect size of 3.85. This means that the material is the material that has the most significant influence.

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