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Effect Size Analysis of the Use of Guided Inquiry-Based Teaching Materials on Students' Competency

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ABSTRACT

Teaching materials are needed in learning to deliver information systematically to students in order to achieve the expected competencies. The real condition in the field show that the use of teaching materials based on certain learning models were still limited. For this reason, this research was conducted to analyze the effect size of the use of guided inquiry-based physics and science teaching materials on students' competence. The research method used is meta-analysis based on effect size with research subjects, namely 20 national and international articles. The results showed that the use of guided inquiry-based physics and science teaching materials was effective in increasing the competence of students at the SMP level with a very high effect size. In addition, the use of guided inquiry-based physics and science teaching materials on teaching materials in the form of modules and textbooks gives a very high effect size and student worksheet and videos gives a high effect size. The use of guided inquiry-based physics and science teaching materials is effective in increasing the competence of students on cognitive learning outcomes with a very high effect size, on critical thinking skills, HOTS, conceptual understanding, and metacognitive abilities giving a high effect size, and on generic science skills gives a moderate effect size.

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INTRODUCTION

The Government of Indonesia through Peraturan Pemerintah RI Nomor 57 Tahun 2021 Article 1 states that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, independence, independence. self-control, personality, intelligence, noble character, and skills needed by himself, society, nation and state. Through these regulations, the government hopes that education can help students actively develop

their potential through the learning process. In an effort to increase student activity, the Indonesian government through a curriculum emphasizes the implementation of learning based on a scientific approach at every level of education and prioritizes student-centered learning (Permendikbud Nomor 22 Tahun 2016 Tentang Standar Proses Pendidikan Dasar Dan Menengah, 2016). One of the learning models put forward in the policy is strengthening the scientific approach, namely inquiry-based learning. Rustaman (2011) revealed that inquiry-based learning provides opportunities for students to continue to develop their potential optimally, both from a cognitive, affective, and psychomotor perspective.

On the other hand, in Peraturan Pemerintah RI Nomor 57 Tahun 2021 Article 6 it is explained that graduation standards at the secondary education level are focused on knowledge to improve student competence. The meaning of competence emphasizes the integrated nature of the domains of attitudes, knowledge and skills. In line with the opinion of Festiyed (2015) that education must be able to prepare students to have learning skills including critical thinking skills, problem solving, communication, collaboration, creativity, and innovation. This shows that inquiry-based learning is expected to meet graduation standards at the secondary education level. One form of inquiry-based learning is guided inquiry.

To find out if there are problems in the implementation of learning and student learning outcomes, a preliminary study was carried out by analyzing several scientific journals related to the use of guided inquiry-based physics and science teaching materials on student competence. The results of the initial study show that there is a difference between the ideal conditions and the real conditions that occur in the field. The reality on the ground does not reflect the expected conditions. The first real condition, the implementation of the 2013 Curriculum is not optimal, the learning applied in learning is still teacher centered using the lecture method. This tends to make students passive in learning and not even paying attention to learning (Rinaldo et al., 2017). In line with the opinion of Usmeldi (2016) that the activeness of students in learning is still low. The second real condition is that the results of the 2018 PISA (Program for International Student Assessment) for Indonesia have decreased compared to the 2015 PISA results.

In the 2015 PISA, Indonesia's math ability and science performance scores were 386 and 403 respectively. Meanwhile, in 2018 PISA, Indonesia's math ability and science performance scores were 379 and 396 respectively (Tohir, 2019). This shows the decline in student achievement in science in recent years. The third real condition, the use of worksheets based on certain learning models is still rarely found (Hayatul et al., 2018). This is in line with Usmeldi (2016), that in general the teaching materials used by educators are teaching materials obtained by educators from training, so the teaching materials used are not in accordance with the characteristics of students and subject matter. Guided inquiry-based teaching materials are expected to be a solution to these problems.

In learning, the teacher acts as a facilitator whose one function is to provide resources or teaching materials for students (Sugiyanto et al., 2013). This is in line with Festiyed (2013), that teachers can provide learning experiences both mental, physical, social, and manage learning places, students, learning activities, learning materials, learning resources, in such a way that students actively ask questions and express ideas. Teaching materials are learning resources that are deliberately developed for learning purposes (Asrizal et al., 2017). Aside from being a tool to achieve learning objectives, teaching materials also aim to make learning more effective. This is supported by Asrizal et al. (2018) that teaching materials are designed as tools that can help educators and students to make learning more effective.

In terms of form, Prastowo (2014) distinguishes teaching materials into four types, namely (1) Printed teaching materials, for example handouts, books, modulees, student worksheets, brochures, leaflets, wallcharts, photos/pictures, and models/models, (2) audio

teaching materials, for example cassettes, radio, LPs, and audio CDs, (3) audio visual teaching materials, for example, video CDs and films, (4) interactive teaching materials (multimedia), for example, interactive CDs. In addition, the implementation of learning in each educational unit, one of which must be carried out in an interactive learning atmosphere, namely a learning atmosphere that facilitates systematic and productive interactions between educators and students, between students, and between students and learning materials (Peraturan Pemerintah RI Nomor 57 Tahun 2021, 2021). Selection of appropriate learning resources and learning models in the implementation of learning really needs attention. Efforts to develop appropriate learning resources include developing teaching materials based on learning models, one example of teaching materials based on guided inquiry models. Theoretically, guided inquiry-based LKPD is the right choice of teaching materials because it can direct students to find their own knowledge concepts and can help teachers to discipline students in finding and compiling concepts with a systematic process (Annafi, 2016).

One of the suggested learning models for science subjects is guided inquiry. Guided inquiry is a way of teaching and learning designed and guided by teachers that directs students to gain an in-depth understanding of subject curriculum content and the concept of information literacy while developing literacy and social skills (Kuhlthau, 2015). Syamsu (2017) added that the application of the guided inquiry learning method can emphasize student learning creativity in finding solutions to problems in an active and independent learning process capable of encouraging students to be more enthusiastic about finding solutions to problems. In practice the role of students is more dominant (student centered) and students are more active while the teacher guides students in the right direction. In line with that, Sukini (2019) argues that the main purpose of guided inquiry is to develop intellectual skills, critical thinking, and the ability to solve problems scientifically. The application of guided inquiry in learning is expected to improve student learning outcomes, both in the realm of attitudes, knowledge, and skills. Based on this description, this study aims to analyze the magnitude of the influence of the use of physics and science teaching materials based on guided inquiry on student competence in terms of educational level, type of teaching materials, and student competence.

METHODS

The method used in this study is meta-analysis. Meta analysis is a way of collecting research data by summarizing, reviewing and analyzing data from several studies that have been conducted. This study analyzes several articles sourced from national and international journals by calculating the effect size of each article that has been collected. Effect sizes were calculated using statistical formulas. The subjects of this study were 20 articles consisting of 16 national articles and 4 international articles published in 2015-2021.

The criteria for the articles to be analyzed included (1) articles examining the effect of using guided inquiry-based physics and science teaching materials on student competence, (2) articles from national and international journals, (3) articles published in the last 6 years. The variable of this research is guided inquiry-based teaching materials which are limited to Physics and Natural Science subjects with the dependent variable namely student competence in terms of educational level, type of teaching material, and student competency.

The implementation phase of this study consisted of (1) identification of the type of research and research variables found and grouped in the appropriate column of variables, (2) identification of the mean and standard deviation of experimental group data or before treatment and control group data or after treatment for each research subjects who have been tested, (3) calculate the effect size using statistics (Becker & Park, 2011). The statistics used in

calculating effect sizes are shown in Table 1.

Table 1. The Formula for Calculating the Effect Size

Statistics	Formula
Average in one group	$ES = \frac{\bar{X}_{post} - \bar{X}_{pre}}{SD_{pre}}$
Average in each group (*two group posttest only*)	$ES = \frac{\bar{X}_E - \bar{X}_C}{SD_C}$
Average in each group (*two groups pre-posttest*)	$ES = \frac{\left(\bar{X}_{post} - \bar{X}_{pre}\right)_E - \left(\bar{X}_{post} - \bar{X}_{pre}\right)_C}{\frac{SD_{preC} + SD_{preE} + SD_{postC}}{3}}$
Chi-Square Statistics	$ES = \frac{2r}{\sqrt{1-r^2}}; \sqrt{\frac{\chi^2}{n}}$
Statistics t count	$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$

Meanwhile, in determining the category of the effect size using the criteria that can be seen in Table 2.

Table 2. Effect Size Criteria

Statistics	Criteria
ES ≤ 0.15	The effect is negligible
0.15 < ES ≤ 0.40	Small effect
0.40 < ES ≤ 0.75	Moderate effect
0.75 < ES ≤ 1.10	High effect
ES > 1.10	Very High effect

RESULTS AND DISCUSSION

Results

The results of the effect size data were obtained after collecting 20 national and international articles according to the criteria of the articles to be analyzed and the research variables. Followed by the provision of article codes from IT1 to IT20. Then calculate the effect size for each article using statistics that refer to Table 1 and the effect size criteria shown in Table 2. The results of the effect size of each article can be seen in Table 3.

Table 3. Effect Size Result Data

Article Code	Effect Size	Criteria
IT1	0.427	Moderate
IT2	1.006	High
IT3	0.821	High
IT4	0.900	High
IT5	0.908	High
IT6	0.728	Moderate
IT7	2.805	Very high
IT8	1.155	Very high
IT9	0.528	Moderate
IT10	0.820	High
IT11	3.581	Very high

Article Code	Effect Size	Criteria
IT12	0.845	High
IT13	0.590	Moderate
IT14	0.956	High
IT15	1.893	Very high
IT16	0.890	High
IT17	4.652	Very high
IT18	0.458	Moderate
IT19	0.410	Moderate
IT20	1.006	High

The data shown in Table 3 shows the article code, effect size, and effect size criteria of each article of guided inquiry-based science and physics teaching materials. It can be seen that there are 6 articles showing an effect size with medium criteria, 9 articles showing an effect size with high criteria, and 5 articles showing an effect size with very high criteria. In general, it can be seen that the articles analyzed are dominated by effect sizes with high criteria. That is, guided inquiry-based physics and science teaching materials have a high influence on student competence.

In this article, the influence of guided inquiry-based physics and science teaching materials on student competence is grouped again based on 3 aspects, namely in terms of educational level, type of teaching material, and student competency. This is done so that the resulting analysis is more detailed. It also aims to make it easier for researchers to compare the results of the effect size analysis with the results of other similar studies. The first result in this study is related to the effect size analysis of the use of guided inquiry-based physics and science teaching materials on student competence in terms of educational level. The results of calculating the effect size data based on educational level are presented in Table 4.

Table 4. Effect Size Calculation Data Based on Education Level

Education Level	Mean effect size	Criteria
SMA (Senior high school)	1.006	High
SMP (Junior high school)	1.532	Very high

The data shown in Table 4 shows educational level, mean effect size, and effect size criteria. In data processing, Table 4 contains 10 articles for the high school level and 10 articles for the junior high school level. Meanwhile, the SD (elementary school) level was not found in the articles analyzed in this study. It is known that at the SMA level the effect size is obtained with high criteria and at the SMP level the effect size is obtained with very high criteria. This shows that guided inquiry-based physics and science teaching materials have a higher influence at the junior high school level than at the senior high school level.

Furthermore, the effect of guided inquiry-based physics and science teaching materials was also analyzed based on the type of teaching materials used. This is so that readers can compare the differences in effect sizes of each type of teaching material. This is because each form of teaching material used will have a different magnitude effect for students. Data from effect size calculations based on the type of teaching materials are presented in Table 5.

Table 5. Effect Size Calculation Data Based on Types of Instructional Materials

Teaching material types	Mean effect size	Criteria
Student Worksheet	0.874	High
Module	2.126	Very high
Teaching material	1.847	Very high
Video	0.845	High

The data shown in Table 5 shows the types of teaching materials used, the mean effect size, and the effect size criteria. In data processing Table 5 there are 12 articles that use teaching materials in the form of worksheets, 4 articles that use teaching materials in the form of modules, 3 articles that use teaching materials in the form of teaching materials or textbooks, and 1 article that uses teaching materials in the form of videos. It is known that physics and science teaching materials based on guided inquiry in the form of worksheets and videos provide an effect size with high criteria. Meanwhile, guided inquiry-based physics and science teaching materials in the form of modules and teaching materials provide an effect size with very high criteria. This shows that guided inquiry-based physics and science teaching materials have a higher influence on teaching materials in the form of modules and teaching materials compared to worksheets and videos.

In addition to obtaining effect size results from articles on educational level and types of teaching materials used, this study also obtained effect sizes based on the type of student competency being measured. This is done so that the analysis produced is more detailed and makes it easier for researchers to compare the results of the effect size analysis for each type of different student competencies. The results of calculating the effect size data based on student competence are presented in Table 6.

Table 6. Effect Size Calculation Result Data Based on Student Competency

Student competency	Mean effect size	Criteria
Cognitive learning outcomes	1.821	Very high
Critical thinking skills	0.951	High
Generic science skills	0.590	Moderate
HOTS	0.820	High
Concept understanding	0.890	High
Metacognition ability	0.956	High

The data shown in Table 6 shows the measured student competency, mean effect size, and effect size criteria. In data processing Table 6 there are 8 articles that measure students' cognitive learning outcomes, 8 articles that measure students' critical thinking skills, and 1 article that each measures generic science abilities, HOTS, conceptual understanding, and students' metacognitive abilities. educate. It is known that guided inquiry-based physics and science teaching materials provide an effect size with moderate criteria on generic science skills. Meanwhile, guided inquiry-based physics and science teaching materials provide a measure of influence with high criteria on critical thinking skills, HOTS, conceptual understanding, and metacognition abilities. In addition, guided inquiry-based physics and science teaching materials provide an effect size with very high criteria on cognitive learning outcomes. This shows that guided inquiry-based physics and science teaching materials have a higher influence on cognitive learning outcomes than other competencies.

Discussion

Data on the effect of using guided inquiry-based physics and science teaching materials on student competence based on educational level is shown in Table 4. Table 4 shows that guided inquiry-based physics and science teaching materials provide a very high effect size at the junior high school level with a mean effect size of 1.532. While at the senior high school level, guided inquiry-based physics and science teaching materials provide a high effect size with a mean effect size of 1.006. This shows that guided inquiry-based physics and science teaching materials provide a more effective influence at the junior high school level. This is in line with the research results of Gunawan et al., 2019, 2021; dan Pasaribu & Prastyo, 2022

which shows that guided inquiry learning is more effectively applied at the junior high school level of education than at the high school/vocational school level. It is supported by research that suitable inquiry learning for junior high school students is guided inquiry-based learning (Astuti & Setiawan, 2013; Fitriyati & Munzil, 2016).

Based on data from the analysis of the effect of using guided inquiry-based physics and science teaching materials on student competency based on the type of teaching material used as shown in Table 5, it shows that guided inquiry-based physics and natural science teaching materials provide a very high effect size in modules and teaching materials (textbooks) with mean effect size values of 2.126 and 1.847, respectively. Whereas in the form of student worksheet and video teaching materials, the influence of guided inquiry-based physics and science teaching materials gave a high effect size with a mean effect size value of 0.874 and 0.845, respectively. The results of this study indicate that each type of teaching material used in learning has a different effect on student competency. However, teaching material in the form of modules is more effective than other types of guided inquiry-based teaching materials (Iryani et al., 2021; Maison & Wahyuni, 2021; Putri & Syafriani, 2020; Yani et al., 2020). Therefore, the selection of appropriate teaching materials needs to be done because teaching materials as a source of learning greatly affect the quality of learning. This is in line with the opinion of Sugiyanto et al. (2013) that the existence of sources and media that can improve the quality of learning is an absolute requirement that must be met to support learning.

Based on data from the analysis of the effect of using guided inquiry-based physics and science teaching materials based on student competency as measured in Table 6, it shows that guided inquiry-based physics and science teaching materials provide a very high effect size on students' cognitive learning outcomes with a mean effect value. size of 1.821. The results of this study indicate that guided inquiry-based physics and science teaching materials have a positive influence, especially on students' cognitive learning outcomes. Guided inquiry-based teaching materials help construct knowledge and improve students' cognitive abilities (Aulia et al., 2018; Faradilla et al., 2018; Hermansyah et al., 2018; Misbah et al., 2018; Nurlaila & Lufri, 2021; Putra et al., 2016; Stender et al., 2018). In line with the results of Sukini (2019) that the application of the guided inquiry model based on a scientific approach using the right steps and good teacher performance influences the increase in cognitive learning outcomes. In Critical thinking skills, HOTS, concept understanding, and metacognition abilities, the use of guided inquiry-based physics and natural science teaching materials provides a high effect size with a mean effect size value of 0.951 respectively; 0.820; 0.890, and 0.956. This is in line with the results of research by Dewi et al. (2020) and Kurniawan & Syafriani (2021) that the application of the guided inquiry model has a positive effect in the form of increasing critical thinking skills.

In addition to having a significant effect on student learning outcomes, guided inquiry-based teaching materials also have a significant effect on students' science process skills (Tanjung et al., 2022). This is in line with Bunterm et al. (2014) who revealed that guided inquiry learning can develop science content knowledge, science process skills and students' process skills. Sadia (2014) added that guided inquiry learning trains students in developing concept understanding skills, and trains the process of conveying the concepts found. In the generic science skills competency, the use of guided inquiry-based physics and natural science teaching materials provides an effect size that is included in the moderate category with a mean effect size value of 0.590. In line with the results of this study, Ermawati et al. (2019) revealed that students' generic science skills have not developed optimally because learning using practicum activities is a new thing for students, so students still experience difficulties in carrying out practicum activities and using visual aids. In addition to being able to increase the competence of knowledge and skills of students, guided inquiry-based teaching materials can also increase students' learning motivation (Fahlevi & Maghfiroh,

2023).

In addition to finding several findings related to the results of the analysis of the effect of guided inquiry-based physics and natural science teaching materials on student competency. This study also has limitations, namely in the analysis of the effect of guided inquiry-based physics and science teaching materials on educational levels, only articles for SMA and SMP levels were obtained, while for the SD level there were no articles analyzed. In addition, the data in Tables 5 and 6 still contain effect size results for the type of teaching material and student competency which are only obtained from one article, so the effect size results obtained do not reflect the actual results. Therefore, it is hoped that further research will complement the study of this article in order to obtain maximum analytical results.

CONCLUSION

The use of guided inquiry-based Physics and Science teaching materials is effective in increasing student competency at the junior high school education level with a very high effect size and providing an effect size with the high category at the high school education level. The use of guided inquiry-based Physics and Science teaching materials is effective in increasing student competency in modules and teaching materials (textbooks) with a very high effect size. In teaching materials in the form of student worksheet and videos, the use of guided inquiry-based physics and science teaching materials provides a high effect size. The use of guided inquiry-based Physics and Science teaching materials is effective in increasing student competency in the cognitive learning outcomes of students with a very high effect size. The use of guided inquiry-based physics and natural science teaching materials gives a high effect size to critical thinking skills, HOTS, concept understanding, and metacognition ability, and provides a moderate effect size to generic science skills.

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