Meta-Analysis: The Effect of Inquiry Learning Model on Students' Critical Thinking Skills

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ABSTRACT

This study aims to analyze the effect of the inquiry learning model on students' critical thinking skills, analyze the magnitude of the influence of the inquiry learning model based on education levels, namely SMP and SMA and analyze the magnitude of the effect of using the inquiry learning model based on grade level, namely VII, VIII, X and XI. Fourth, analyze the influence of the use of the inquiry learning model based on the topics of Biology and Science learning materials being taught, namely the Excretory System, Volcanoes, Digestive Systems, Cells, Ecosystems, Circulatory Systems and Environmental Pollution. The method used is meta-analysis, which analyzes 10 articles within a period of 3 years from previous research. The technique used is a meta-analysis technique with descriptive analysis method by analyzing several articles of accredited national journals. Research data collection is done by searching for articles with the help of Google Scholar. The effect size value is obtained from the research that has been done. The effect size related to the whole article regarding the effect of the inquiry learning model on students' critical thinking skills in biology subjects is 1.45 with a very high category. The effect size based on education level is 1.49 for junior high school level and 1.40 for high school level. Effect size based on grade level is 1.65 for class VIII SMP and 1.63 for class XI SMA. The effect size based on the topic of the subject matter is 2.93 on the excretory system material. The conclusion of the study is that the inquiry learning model influences students' critical thinking skills in biology subjects.

Keywords: 21st century skills, effect size, meta-analysis

INTRODUCTION

Entering the current 21st century, Human Resources (HR) are required to continue to compete globally. This is stated in the goal of 21st century education in Indonesia, which is to be able to compete globally for advanced education. 21st century skills include creativity,

communication, collaboration, and critical thinking. These 21st century skills are essential in the learning process and show these results through activities or performance (Junedi, Mahuda, & Kusuma, 2020). These skills are the 4C skills, namely critical thinking, communication, creative thinking, and collaboration, of course in learning will have an extraordinary impact on facing global challenges in the 21st century (Sugiyarti, Arif, & Mursalin, 2018). Of the 4 skills, researchers focused on critical thinking skills. Because these skills are recognized as essential skills (Prayogi, Yuanita, & Wasis, 2018). Critical thinking skills are important to develop in learning, where students are required to be active in learning and the teacher is only a facilitator (Fitriyyah & Wulandari, 2019; Putriningtyas, Muhlis, & Bachtiar, 2022; Safitri & Mediatati, 2021).

Critical thinking is the ability to identify a problem, find information related to existing problems and then analyze, and determine steps for solving and making conclusions and accuracy in making a decision (Maryam, Kusmiyati, Merta, & Artayasa, 2019). Critical thinking skills are an important part of being trained in the learning process, because they will be everyone's capital to improve their learning achievement, so it is important to apply them at all levels of education (Fitriani, Asy'Ari, Zubaidah, & Mahanal, 2018). Critical thinking skills aim to make students better understand the meaning of learning. Of course, this will have an impact on increasing student learning abilities (Yanti, Siregar, & Nasution, 2020). Several research studies show that critical thinking skills lead to significantly increased learning abilities and student achievement.

Through learning biology can help students to have skills in solving a problem so that it will hone critical thinking skills. This is because in studying biology, students not only understand concepts, but also have scientific methods (Kurniawati, Festiyed, & Asrizal, 2019). The steps of the scientific method are making observations, compiling hypotheses, conducting experiments, analyzing data, and drawing conclusions (Fitriyani, Haryani, & Susatyo, 2017). The more students are familiar with procedures in the scientific method, namely honing critical thinking skills and students can solve a problem and compete globally (Kurniawati et al., 2019; Mardayani, Syahril, & Rizal, 2019; Ratnawati, Handayani, & Hadi, 2020).

However based on research problems (Andayani, Raharjo, & Budijastuti, 2021), students experience boredom and lack of motivation to take biology lessons because learning is only one-way (direct instructional) without an active role from teachers and students. Thus, the teacher

has the accuracy in choosing a model in the process so that students' critical thinking skills are created. To improve these skills, involve the role of students in examining concepts by searching for material independently in the ongoing learning process (Maryam, Kusmiyati, Merta, & Artayasa, 2020; Muhammad Santoso & Arif, 2021).

The inquiry learning model in its syntax includes the process of searching for concepts based on experience or relevant sources (Harahap, Turnip, & Sembiring, 2020). Therefore, students are independent in learning and make learning more meaningful (Maryam et al., 2020). Based on previous research, the results show that the use of the inquiry learning model has a major effect on students' critical thinking skills (Amijaya, Ramdani, & Merta, 2018; Furmanti & Hasan, 2019; Husna, Indriwati, & Saptasari, 2020). For this reason, teachers can use this inquiry learning model in the learning process.

Inquiry learning model can be proven its effectiveness on critical thinking skills by analyzing using meta-analysis techniques. Meta-analysis is an analytical technique to conclude the results of several or more studies that aim to combine, view, and summarize previous research (Agnezi & Rahmah, 2020). Based on the previous explanation, this study aims to determine whether the inquiry learning model has an influence on students' critical thinking skills in the field of biology studies.

METHOD

This study uses a meta-analysis research method. This type of research is quantitative because it uses numerical and statistical calculations. The data collection technique used is a meta-analysis technique with descriptive analysis method by analyzing several articles of accredited national journals. Research data collection is done by searching for articles with the help of Google Scholar. The articles used are articles from 2018-2020 to be more up-to-date. The sample used is 10 nationally accredited relevant journal articles from various Biology subject matter integrated in the inquiry model on critical thinking skills.

Furthermore, the articles that have been obtained are coded to facilitate data collection, namely with codes A01 to A10 for each article. The analytical technique used is a comparison method to determine the effectiveness of the inquiry learning model. The analysis used in this study is to find the effect size value, which is to determine the average difference between the experimental group (inquiry learning model) and the control group (other learning models) then

divided by the standard deviation of the control group. After that, the effect size value is obtained and includes it in several criteria.

The procedures in this study are explained in more detail, namely: (1) determining the topic or research problem; (2) determine the range of years that will be used as data samples; (3) search for journal articles according to the criteria from various relevant sources; (4) determine the effect size of each journal article; (5) grouping based on levels, class levels and topics of Biology material; (5) make a summary for analysis.

As for how to find the effect size (ES) can be calculated using the following Glass formula:

$$ES = \frac{\bar{X}e - \bar{X}c}{S_C}$$

After getting the effect value, it can be categorized in the effect size criteria, which can be seen in Table 1:

Table 1. Effect Size Interpretation Criteria

Effect Size	Verbal Description
Effect size ≤ 0,15	Negligible effect
0,15 < effect size ≤ 0,40	Low Effect
0,40 < effect size ≤ 0,75	Moderate Effect
0,75 < effect size ≤ 1,10	High Effect
1,10 < effect size ≤ 1,45	Very High Effect
1,45 < effect size	Very High Influence

(Glass, McGraw, & Smith, 1981)

RESULT AND DISCUSSION

In this study, the articles used were 10 articles of nationally accredited relevant journals from various Biology subject matter integrated in the inquiry model for critical thinking skills. The article will be categorized again based on various research topics, educational levels, and grade levels under study to find out more specifically the effectiveness of the inquiry learning model on critical thinking skills determined by the effect size. Articles obtained with the help of Google Scholar. Journal articles were analyzed starting from 2018 to 2020. Then, the articles that had been obtained were coded (code category) to facilitate data collection, namely with codes A01 to A10. Table 2 shows the data analysis of research results containing article code, research topic, name of researcher and year of publication.

Table 2. Research Result Data

Article Code	Research Topics	Researcher	Year
A01	Inquiry Learning Model, Critical Thinking Ability, Class XI, Excretion System Material	Susilowati, Sajidan, Murni Ramli	2018
A02	Inquiry Lesson-Based Media, Critical Thinking Skills, Learning Outcomes, Class VII, Volcano Material	Muhammad Firdaus, Insih Wilujeng	2018
A03	Model Argument Driven Inquiry (ADI), Critical Thinking Skills, Class VIII, Digestive System Materials	Dewie Permata, Neni Hasnunidah, Arwin Surbakti	2019
A04	Inquiry Learning Model, Critical Thinking Ability, Student Motivation and Activeness, Class VIII, Science Subject	Tessy Furmanti, Rusdi Hasan	2019
A05	Inquiry Learning Model, Critical Thinking Skills, Class XI, Cell Materials	Maryam, Kusmiyati, I Wayan Merta, I Putu Artayasa	2019
A06	Guided Inquiry Learning Strategy, Critical Thinking Ability, Class X, Ecosystem Material	Syahraini Ritonga	2019
A07	Guided Inquiry Model, Inquiry Learning, Critical Thinking, Class VIII, Science Subject	Edo Ramadan, Irwandi, Eva Oktavidiati	2019
A08	Guided Inquiry Methods and Projects, Biological Critical Thinking Skills, Class VIII, Human Circulatory System	Hasmi Syahputra Harahap, Julion Turnip, Al Khudri Sembiring	2019
A09	Inquiry Learning Model, Students' Critical Thinking Skills, Class XI, Cell Materials	Maryam, Kusmiyati, I Wayan Merta, I Putu Artayasa	2020
A10	Guided Inquiry Model, Class X, Environmental Pollution Material, Critical Thinking Ability	Hadijah, Safilu, Muzuni	2020

Based on the 10 articles above, they are distributed based on education level, namely SMP and SMA, class level, namely class VII, VIII, X and XI and various topics of Biology subject matter. The distribution of the 10 articles can be seen in details which refer to Table 3.

Table 3. Distribution of 10 Sample Journal Articles

Information	Level of Education	Class Level	Topic Learning Material
Junior High School	5		
Senior High School	5		
VII		1	
VIII		4	
X		2	
XI		3	
Excretion System			1
Volcano			1
Digestive System			1
Cell			2
Ecosystem			1
Circulatory System			1
Environmental pollution			1
Quantity	10	10	8

Table 3 describes the details of journal articles on inquiry learning which are distributed into levels, classes, and material topics. Then the effect sizes obtained from 10 journal articles using the Glass formula (Glass et al., 1981), can be seen in Table 4.

Table 4. Effect Size Results of 10 Sample Journal Articles

Article Code	Effect Size	Category
A01	2,93	Very High
A02	0,87	High
A03	1,57	Very High
A04	0,72	Moderate
A05	0,98	High
A06	1,59	Very High
A07	2,94	Very High
A08	1,37	Very High
A09	0,98	High
A10	0,55	Moderate
Average	**1,45**	**Very High**

Based on the recapitulation of the results of the effect size of the 10 samples of journal articles listed in Table 4, the majority of the ten studies analyzed, there were 5 journal articles in the very high category, which had an effect size ranging from 1.37 to 2.94, there were 3 journal articles in the high category. has an effect size with a range of 0.87 to 0.89 and there are 2

moderate category journal articles that have an effect size of 0.55 and 0.72. If averaged, get an average effect size value of 1.45 (very high). So, it can be concluded that there is an influence of the inquiry learning model in biology learning in improving students' critical thinking skills. The analysis is continued by looking at the effect of the inquiry learning model on educational levels. Of the 10 existing journal articles, they were grouped by junior and senior high school levels, then the average effect size was calculated. The recapitulation results refer to Table 5.

Table 5. Effect Size Based on Education Level

No	Education Level	Number of Research	Effect Size	Category
1.	Junior High School	5	1,49	Very High
2.	Senior High School	5	1,40	Very High

As for the results of this inquiry model on increasing students' critical thinking based on junior and senior high school education levels, it was found that the inquiry learning model both had a very high effect. However, at the junior high school level it has a higher effect than at the high school level. Furthermore, the analysis carried out is to look at the influence of the inquiry learning model on class levels. Based on the articles analyzed, there are 4 different grade levels. The results of data analysis recapitulation can refer to Table 6 below:

Table 6. Effect Size Based on Class Levels

No	Class Levels	Number of Research	Effect Size	Category
1.	VII	1	0,87	High
2.	VIII	4	1,65	Very High
3.	X	2	1,07	High
4.	XI	3	1,63	Very High

Looking at Table 6 based on class levels VII to XI, the influence of the inquiry learning model has a high to very high effect on critical thinking skills. At the class VIII level it has a very high effect and at class VII it has a high effect. The next analysis looks at the influence of the inquiry learning model on the topic of biology learning material. Based on the articles analyzed, there are 7 topics of learning material. The results of the recapitulation of data analysis refer to Table 7.

Table 7. Effect Size Based on Topic Learning Materials

No	Topic Learning Materials	Number of Research	Effect Size	Category
1.	Excretion System	1	2,93	Very High
2.	Volcano	1	0,87	High
3.	Digestive System	1	1,57	Very High
4.	Cell	2	0,98	High
5.	Ecosystem	1	1,59	Very High
6.	Circulatory System	1	1,37	Very High
7.	Environmental pollution	1	0,55	Moderate

Based on 7 topics the material is in the medium to very high category from the range of 0.55 to 2.93. From the meta-analysis that has been carried out, overall, it is obtained that the inquiry learning model has an effect on critical thinking. There is one material, namely the environmental pollution chapter which has an effect value of 0.55 in the medium category. Then, for more details regarding the discussion of the research results, it will be detailed as follows.

All articles that have been analyzed, get an effect value with a very high category. If the percentage is 50% in the high category, the percentage is 30% and the percentage is 20% in the medium category. While the average of the 10 journal articles analyzed is 1.45 in the very high category. From these results, we can see that the inquiry model has a high influence in improving students' critical thinking skills. This is because, the inquiry model emphasizes that students analyze problems and their own answers so that it will improve students' critical thinking.

In line with research (Amijaya et al., 2018) that in the class that was applied the guided inquiry model was obtained an increase of a value of 27.42. This is obtained from knowledge that involves mental activity in analyzing, evaluating questions, ideas and arguments, and looking for evidence of something based on facts that are believed to be true (Yanti et al., 2020). In line with research from (Yuhana, Maridi, & Dwiastuti, 2019) it was stated that the average value of students' critical thinking skills was from 61.47 to 80.60 and this showed an increase.

Based on the educational level, the research data are shown in Table 4, that the effect size value is in the very high category at the junior and senior high school levels. This is because, the higher the level of education, students can analyze relevant data to be used as a source and of

course will hone critical thinking skills. So, it shows that the inquiry learning model is influential and effectively used at the junior and senior high school levels to improve and hone critical thinking skills. In line with research conducted by (Ramadan, Irwandi, & Oktavidiati, 2019) it was found that guided inquiry was effective in increasing students' critical thinking in class VIII at junior high school level. This is because the junior and senior high school levels are already able to think abstractly and logically (Kurniawati et al., 2019). So, educators can use the inquiry model on students for junior high and high school levels.

Based on the class level, the research data can be shown in Table 5 that the result of the effect size is 0.87 to 1.65 in the high to very high category. The very high category is occupied by class VIII and XI, because at a high grade level, students can analyze various sources to get valid answers. This shows that the higher the class level, the higher the effect size value obtained. According to (Hiryanto, 2017) the more mature the higher the ability to think and responsibility for learning tasks. In this case it shows that there is influence and effectiveness of the inquiry model in learning in increasing critical thinking. For this reason, teachers can apply the inquiry model at various grade levels to improve students' skills.

Referring to Table 7, the effect of the inquiry model on students' critical thinking skills on the topic of biology subject matter. The results show that the excretory system material gets a high effect value. This is because biology material contains practical activities in which students will play an active role in experimenting and analyzing problems and will improve critical thinking skills. In line with research (Susilowati, Sajidan, & Ramli, 2018) there is an increase in critical thinking skills in the topic of excretory system material because it contains practical activities and problem studies that will trigger students' critical thinking. The effect size obtained is 2.93 in the very high category. This shows that the biology learning materials on the 7 topics used can hone critical thinking skills. Biology emphasizes the scientific method so that it will support curiosity that can hone critical thinking skills so that it will improve the learning process in students (Iskandar, Nurfadiah, Yuli, & Desnita, 2021).

CONCLUSION

Based on the results of the study, the inquiry learning model has a high effect on students' critical thinking skills seen from the effect size value reaching 1.45 (very high). Based on the level, the inquiry learning model is suitable for use at the junior high and high school levels in

improving students' critical thinking skills. Judging from the class level, the effect size value is in the very high category in class VIII and XI. Based on the learning material, the topic of the excretory system has a high influence on improving critical thinking skills when using the inquiry learning model.

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