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## 22 Description of meta-analysis of science learning through inquiry model in improving students' science process skills

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**Abstract.** This meta-analysis was the result of the preliminary study aimed to describe the analysis of science learning through inquiry model in improving students' science process skills. This study analyzed ten national research journals and five international journals. Analysis of data used a description of the results of the average effect size (ES) of any studies that were sampled, and then categorized based on the interpretation of the criteria Cohen's. The results showed that science learning which was conducting through inquiry model can improve students' science process skill which was indicated by the average effect size of 0.51 with category "medium". Based on the criteria Cohen's also analyzed about the differences in science process skills based on group of countries, fields of study, and levels of education. The results of this study can be concluded that inquiry-based learning can be applied to the development of science learning in order to grow students' science process skills.

### 1. Introduction

Sciences deals with how to find out about nature systematically, so that science is not only just a mastery of a collection of knowledge in the form of facts, concepts, or principles, but also a process of discovery [1]. Learning science emphasis on direct experience to develop the competencies that students are able to understand the nature around through the process of figuring out and do [2]. The skill of finding out or acting is called the investigation process skill or inquiry skill that include observing, classifying measurements, asking questions, preparing hypotheses, planning experiments to answer questions, classifying, processing and analyzing data, applying ideas to new situations, using simple tools, and communicating information through various means e.g with images, oral, writing, and so on [3].

In fact in many countries, including Indonesia, science process skills are still untouched in learning. Reflected in the results of the study of PISA in 2012, it is known that the ability of science students Indonesia is still low. The average score of Indonesian students' scores is 382, ranking 64 out of the 65 participating PISA countries [4].

One alternative method of learning that is expected to overcome the low science process skills in science learning is the method of inquiry. Inquiry-based science learning invites learners to build knowledge about nature actively [5]. Through inquiry learning, students try to raise questions, collect data through observation, investigation, and acquire scientific knowledge, and use the skill to explain the observed data [6].

Many results of research revealed that the guided inquiry learning can significantly affect students' science process skills e.g research that has been done [7] stated that the guided inquiry learning model was more effective than a structured approach to delivering science and science process skills. The results of research [8] showed that the guided inquiry by analogy had a significant impact on students' science process skills acquisition.

Based on the description, the authors are interested in describe more about the meta-analysis of learning science using inquiry model in improving science process skills.

## 2. Method

The method that was used in writing this article was choosing 10 international research journals and 5 national journals which applied a model of inquiry learning and used statistical calculations of effect size. Statistics of the effect size (ES) is a formula that is used to evaluate the impact of treatment in a systematic review of studies, including a meta-analysis, common formula which is used is the formula of Glass [9]. Then effect size (ES) is categorized based on the interpretation of Cohen's [10].

## 3. Result and Discussion

### 3.1. List of studies and effect size of journals

The results of analysis of fifteen journals of inquiry learning models on science process skills, which includes categories of study and the effect size (ES), can be seen in Table 1.

**Table 1.** List of studies and effect size of journals.

No.	Author	Country	Field Studi	Experiment	Control	Total of respondents	UE (category)
1	[11]	Mid East	IPA / University	Inquiry-based Instruction	Conventional	85	0.41 (m)
2	[12]	Turkey	IPA / Elementary	Inquiry Basic Learning	Conventional	20	0.37 (m)
3	[13]	Turkey	IPA / Elementary	Inquiry	Conventional	241	0.3 (m)
4	[8]	Nigeria	IPA / High School	Guided inquiry	Conventional	84	0.69 (l)
5	[14]	Thailand	Chemistry / High School	Inquiry Basic Learning	Conventional	136	0.9 (l)
6	[15]	Indonesia	Biology / High School	Guided inquiry	Conventional	30	0.54 (m)
7	[16]	Nigeria	Biology / High School	Inquiry	Lecture	160	0.1 (s)
8	[17]	Indonesia	Biological / High School	Guided inquiry	Learning directly	140	0.32 (m)
9	[18]	Indonesia	Biology / High School	Guided inquiry	Lecture	119	0.8 (l)
10	[19]	Korea	IPA / Elementary	Guided inquiry	Conventional	62	0.38 (m)
11	[20]	Taiwan	Biology / High School	Guided inquiry	Conventional	232	0.28 (s)
12	[21]	Indonesia	IPA / High School	Guided inquiry	Conventional	380	0.5 (m)
13	[22]	USA	Biology / University	Guided inquiry	Conventional	88	0.7 (l)
14	[23]	Indonesia	IPA / High School	Guided inquiry	Conventional	60	0.9 (l)
15	[24]	Turkey	IPA / Elementary	Guided Inquiry	Conventional	427	0.54 (m)
Average of Effect Size							0.51 (m)

Information:

UE = Size Effect; l = large; m = medium; s = small

Based on the table above, average of ES is 0.51, the value is included in the category of "medium" [10], this means that there are significant differences in students who are treated using the inquiry model with conventional learning that focuses on science process skills.

According to research that science learning by inquiry gave a positive influence on students' science process skills. Inquiry learning is more effective in helping students to acquire science process skills because students directly involved such as asking questions in an informal setting, test hypotheses, and build an explanation [12].

The activities that took place during inquiry learning not only contributed to the science process skills but also the students' understanding of science concepts so that students' learning outcomes increased if the learning of inquiry that actually implemented the syntax in the learning of the inquiry [23].

It found largest ES is 0.9, results of the study [14] and [23]. The reason is that both groups used guided inquiry learning model that basically acquire knowledge by conducting scientific work in advance so that students can better understand the science process skills as integrated in learning syntax. Similarities between guided inquiry learning syntax with indicators of science process skills that may result in differences in students' science process skills between the experimental group and the control group.

In addition, from the results of the above study there are moderate ES (0.3), it means that inquiry strategy contributes significantly to better understanding compared with strategy of conventional [13]. This is due to the systematic and organized nature of inquiry strategies developed and implemented where learners are directly involved in various learning activities that enable learners to know and develop their own knowledge of abstract concepts individually or in groups using skills and skills at the planning, implementation, evaluation, reporting and listing [18]. In the application of inquiry learning the learners are also trained to formulate hypotheses, record collecting materials, and analyze data and draw conclusions. While the conventional strategy is teacher-centered, students are passive, with little or no interaction with teachers.

### 3.2. Effect size chart by country and subjects

Figure 1 shows that the mean of effect size of inquiry on process skill in Indonesia is higher (0.61) than the other countries such as Nigeria and Taiwan that is 0.46. But the effect size of other foreign countries such as USA and Thailand is higher than the state of Indonesia. It is possible in other countries for example in the country of Thailand the method commonly applied in learning is student centered [26].

The learning revolution in developed countries applies a learning model that actually engages students actively in every learning process, as evidenced by the increase in student achievement in Arizona in Chemistry from 52% to 93% [27]. The average ES was inquired on higher scientific process skills in the field of Chemistry studies with a score of 0.9 compared to the Biology study field (0.45) and the field of IPA study (0.51). This is because the article with the field of Chemistry studies there is only one while the second highest after the field of study of Chemistry is the field of science study.

The average ES on students of higher education and secondary education based on Cohens's criteria, including high category, ranked higher than ES in elementary education classified as high category. According to Piaget, junior and senior high school students are entering into the formal operational stage, where students already have a model of scientific thinking [28].

The average value of ES in higher education is 0.55, this value is higher than level of basic education. This is because students at the university level have higher cognitive development than primary and secondary school. So that any learning method given, the students will be easier to understand.

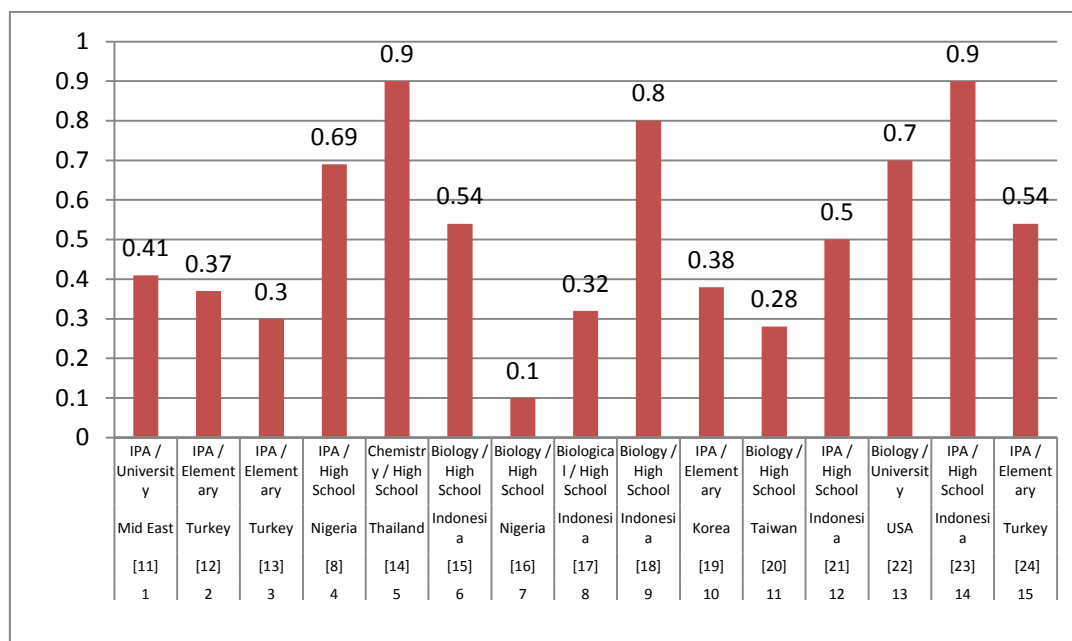


Figure 1. Chart of effect size by countries and subjects.

#### 4. Conclusion

Based on various analysis of study results either based on country or subject it can be concluded that inquiry-based learning can be applied to the development of science learning in order to grow students' science process skills if the syntax in inquiry model are implemented consistently in learning especially on science subjects.

#### Acknowledgments

This writing is the result of a meta-analysis that is guided by Dr. Tri Jalmo, M. Si, who is a head of program study and lecturer from Faculty of Teacher Training and Education University of Lampung.

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