Description of Meta-analysis of Inquiry-based Learning of Science in Improving Students' Inquiry Skills

By Abdurrahman

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M A Firman[1*], C Ertikanto[2] and A Abdurrahman[2]

[1] Mahasiswa Program Studi Magister Keguruan IPA, Universitas Lampung, Jl. Prof. Dr.Sumantri Brojonegoro No. 01, Bandar Lampung, Indonesia
[2] Staf Pengajar Program Studi Magister Keguruan IPA, Universitas Lampung, Jl. Prof. Dr.Sumantri Brojonegoro No. 01, Bandar Lampung, Indonesia

*andii.firman2@gmail.com

Abstract. This meta-analysis is the result of preliminary research which aims to describe the effectiveness of inquiri-based science learning in effort to improve students' inquiry skills. The study of meta-analysis with observation method and analyzed of fifteen journals, literature review using Google search engine in Journal of Baltic data base, ERIC journals (Education Resources Information Center and Google Scholar). Calculation of analysis used average Effect Size (ES) , analyzed the articles as research samples, then categorized based on Cohen's criteria The results of the data analysis obtained average Effect Size of 0.45, with the category "medium". Variations between levels of education and the country of researchers in the journals, the highest effect was on the state of America with a score was 0.88, with the category "high" in elementary school level. Based on the analysis of all samples of this study concluded that inquiry-based learning can be used in the development of science learning and improving of students inquiry skills on each level of education.

1. Introduction

The results of study from Program for International Student Assessment (PISA) turn out that many countries are below the average standard of PISA in terms of science achievement. Hungary, Saudi Arabia, Mexico, and Indonesia are some countries with average of science achievements that are below average standard of PISA [1]. Curriculum 2013 in Indonesia is the application of a scientific-based curriculum which is the government's efforts in developing scientific of thinking ability and improving the ability of inquiry / researching of students in all levels, from elementary, junior and senior high school [2].

The Science approach in the form of Inquiry based-learning (IBL) is most commonly referred to as Inquiry based science education (IBSE) and is currently considered one of the most effective ways to improve science education. Strategy of inquiry focuses not only on science but also on other disciplines, such as mathematics and informatics [3]. The literature on teacher's revolution shows that teacher's revolution is a slow and often difficult process and no later than when initiatives require teachers to review and change their assessment practices [4].

Inquiry in education serves to empower students to see themselves as researchers who are able to reinvent the lessons and to see such subjects as for example in the field of biology, students can define activities in every day life. Guided inquiry activities aimed at finding and understanding programming concepts with Process Oriented Guided Inquiry Learning (POGIL) methods and they emphasize their

potential for informatics education. This shows that Inquiri's learning is not only suitable in developing science science skills but in other subjects [5,6]. Inquiry-based learning, often refered to IBL, is a model of a scientific approach that has become a model for reform of a science education curriculum that is oriented towards developing young people's ability to work scientifically and is the best way students learn science, effective learning approaches and provision innovative of curricular materials [7]. However, sometimes studies only look at the results of cognitive dimensions only, and pay less attention to process assessments that should involve others in assessing the learning process and student investigation skills.

Inquiry has been prominent in science education, but refers to at least three distinct categories of activity by scientists (eg, conducting investigations using scientific methods), how students learn (eg, actively asking through thought and performing phenomena or problems, often times reflecting the processes used by scientists), and the pedagogical approach teachers use (eg designing or using curricula that allow for expanded investigations) [8]. However, whether it be a scientist, student, or teacher who is conducting or supporting an investigation, so the action like that has several important components.

Some researchers argue that the implementation of the IBSE has a disadvantage the time between idea recognition and teacher training at the service and pre-service levels. There is a fundamental problem of the IBSE approach that lies in its assessment of the low level of IBSE type items in national and international assessments that instruct teachers that IBSE is not considered important in terms of science education skills. It is clear that there is a need to produce models of assessment and support materials to assist teachers in assessing IBSE learning in the classroom if this approach is developed and maintained further in classes across [4]. Viewed from the description of the extent to which the effectiveness of inquiry-based learning or IBL, then conducted a meta-analysis of several studies conducted by several researchers both in Indonesia and abroad / foreign countries in the context of experimental design. It will describe of a number of inquiry-based learning strategies, effectiveness, and challenges in an effort to develop students' science learning skills. This study aims to analyze the systematic reviews reviewed from the studies that have been done based on quantitative approach.

2. Method

This research uses meta-analysis method in the form of systematic review to review the research that has been done based on quantitative approach. This systematics aims to see the effectiveness of inquiry-based learning. The steps in the study of meta-analysis by Aslikhah [9] are (1) Determining and studying the research topics to be summarized, (2) Finding and collecting a number of studies with the selected topics and selecting them, (3) (ES) by methods in metaanalysis and hypothesis testing of effect size (ES), and (4) Drawing conclusions and interpreting the results of meta-analysis research. Trusted sources come from inquiry research, through Google search engine and Google Shcoler which focuses on Journal of Baltic data base and ERIC (Education Resouces Information Center) data base by entering keywords in the search dialogue table as follows: inquiry, inquiry-based learning , and studend inquiry skill.

Effect Size Statistics is a long-used formula for evaluating the effects of treatment or treatment in systematic review reviews, including meta-analysis studies. The common formula used is the Glass Delta [10]. A more complex and precise formulation involving treatment with pre-post-control group design was proposed by [11] modifying the Glass Delta equation.After obtaining the EU values from the meta-analysis of the articles taken as samples, the next step is to look at EU criteria based on Cohen's deffect size criteria [12].

3. Results and Discussion

The results of this study were obtained from 15 articles consisting of 4 researchers from Indonesia and 11 other countries who discussed the use of Inquiry based Learning in the context of students' science skills. This study is also a developmental form of review design of systematic research results in the form of a meta-analysis that explores the impact of variations in instructional interventions in different disciplines [9]. The Securities Size Calculation uses the Effect Size Statistics used for meta-analysis

analysis. Based on the Effect Size Calculation performed the results obtained metaanalysis presented in Table 1. follows:

Table 1. Result of effect size meta analysis based on research sample

No	Authors (Journal Year)	Country	Field of study (Level)	Method	N	Effect Size (Category)
1	[13]	Indonesia	Science (Junior High)	IBL, STAD, and Traditional	136	0,23 (Small)
2	[3]	Slovakia	Physics (Senior High)	IBSE and Traditional	300	0,39 (Medium)
3	[14]	Iran	Science (Primary)	IBL and Traditional	40	0.39 (Medium)
4	[15]	Thailand	Science (Primary)	PjBL and IBL	88	0,01 (Small)
5	[16]	Turkey	Science (Primary)	IBL and Traditional	20	0.53 (Medium)
6	[17]	Turkey	Science (Primary)	Discovery, Inquiry and Traditional	57	0.87 (Large)
7	[18]	Turkey	Science (Primary)	IBL and Traditional	241	0.40 (Medium)
8	[19]	Israel	Biology (Senior High)	Dynamic Inquiry, Guided Inquiry, IBL, and Open Inquiry	50	0.56 (Medium)
9	[20]	USA	Science (Primary)	IBL	234	0.88 (Large)
10	[21]	Turkey	Physics (Universitasy)	Hands on eksperiment	28	0.68 (Large)
11	[22]	Turkey	Science Teacher	Inquiry Learning and Traditional	60	0.32 (Medium)
12	[23]	Israel	Science (Junior High)	Science Inquiry	750	0.25 (Small)
13	[24]	Indonesia	Science (Junior High)	GIL and Traditional	65	0.25 (Small)
14	[25]	Indonesia	Biology (Senior High)	GIL and Traditional	50	0.75 (Large)
15	[26]	Indonesia	Science (Junior High)	GIL, Demonstration and Discussion	65	0.33 (Medium)
Average *Effect size*						0,45 (Medium)

Based on the analysis, the effect of Effect size distribution from the whole study can be seen in Table 1. Both of the lowest junjang namely primary school and college. Overall, the average effect size obtained from 15 researcher articles get an effect size of 0.45, the size on average is included in the Medium category. The contribution of each data is different, including the category of redah, medium or high. This shows the variation of each sample used in this study. The above facts show that inquiry-based learning in the context of science itself generally has a enough positive effect on obtaining the skill of the inquiry, in this case that is student's inquiry skill.

Variations from various countries and levels of school ranging from elementary school, secondary school, high school, to undergraduate have shown that an inquiry-based learning model has opportunity to develop knowledge based on science or science learning by conducive. Table 1 shows that almost all studies focus on improving the mastery of science concepts, social activities through collaborative learning, and how students acquire science ephistemology in the context of inquiry-based learning.
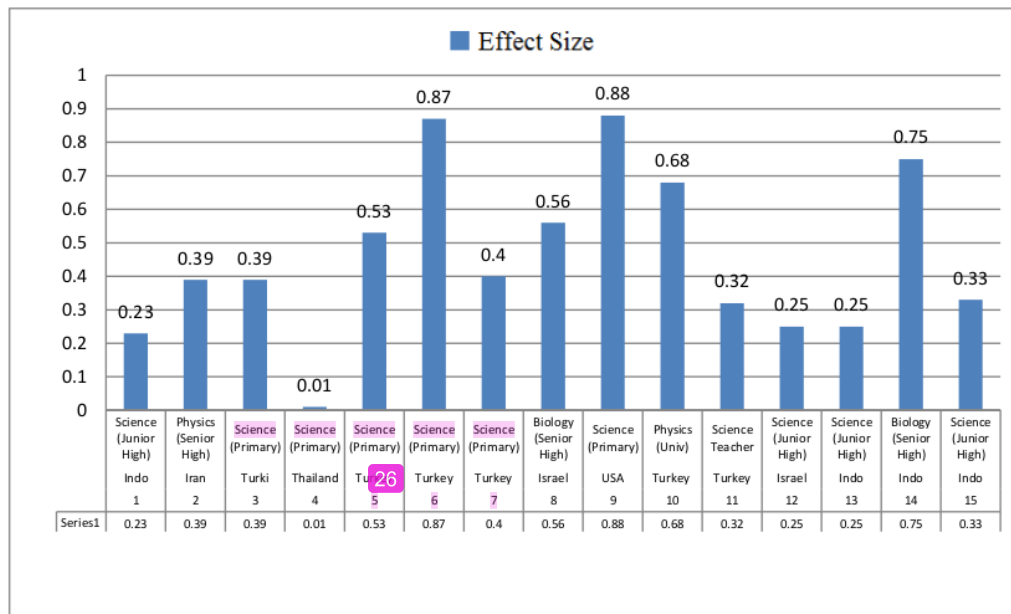
Figure 1. Effect Size of Each Sample by Country and Subject

The variety of classroom development situations conducted by researchers almost entirely aims to increase the involvement of students activities and the effectiveness of learning especially to develop the skills of science processes and cognitive activity for students [9]. Overall results of study show that groups of students involved in inquiry skill activities are capable of developing cognitive abilities optimally compared to groups of students who study science with conventional or traditional learning models.

Some of the things that are discussed also are the results of an interesting study of the meta-analysis that has been done, this is related to the application of inquiry-based learning in some developing countries such as Indonesia, Slovakia, Iran, and Thailand. However, countries such as the United States of America, although there are many variations of this, it shows that the impact of inquiry-based science learning in the adijaya countries is also in the process of development. According to [9] developing countries such as Indonesia, Kenya, and Thailand are included in the category of highly influential (Large Effects) shows that the potential of inquiry-based science learning has the potential to increase students' inquiry of attitude, knowledge and skill aspects. Therefore, inquiry-based science learning has become one of the components of learning and education reform in developing countries, including Indonesia [27]. However, other matters related to this meta-analysis are the inquiry skill that is observed or the focus, it certainly also influences because the process of inquiry itself is inquiry skill. There is a component that is the focus of inquiry skill that causes countries like America is bigger than developing country like Indonesia and others, America applies to process ability so that its skill inquiry is bigger than its Cognitive [3].

Variations of inquiry implementation in developing countries compared to developed countries such as USA or other well-known educational countries such as Turkey, and some European countries are in developing nations inquiry such as Slovakia and Czech are still dominated by structured inquiry levels and guided inquiry, while inquiry in developed countries are more likely to use open inquiry and even inquiry development has been carried out training to teachers not only the cognitive but also the process of investigation. However, this difference does not necessarily reduce the continuous reform of science learning, Asia-Pacific countries have also adopted a scientific approach in science learning in the classroom, especially in Indonesia. Education for the development of professional teachers involves

students to character as educators of science, they will assimilate scientific inquiry as well as scientific literacy as well. Inquiry-based learning from China can be implied in science school [28]. Empirical studies show that inquiri-based classes can help students to achieve science education goals. It is understood by science teachers to involve their students in scientific investigation, scientific nature, and scientific literacy. Inquiry-based learning should not be found only in school science but it can be for all, which means developed by community members whose scientific literacy base, and knowledge-based society. This provides an overview of learning-oriented inquiry-based learning that will provide high opportunities for student involvement in the learning process of science, to activation and student inquiry skills in learning if learning environment, learning situation, teaching materials used , as well as teachers who play a role in the learning is able to create creativity and the ability to analyze in thinking in the classroom can be well used, it would be the creation of the main goal for the achievement of the learning objectives themselves.

4. Conclusion

Based on the results and wetting in the meta-analysis of a number of articles indicates that this learning development is promising and can be used as a guide in efforts to reform the implementation of science-based curriculum. The positive impact of inquiry-based learning is indicated by average Effect Size Medium categories and variations in some countries provide reinforcing confidence that students actively engage in Inquiry.

Acknowledgments

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