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Application of the Levels of Inquiry Method in Increasing Student Achievement in IPBA Materials

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ABSTRACT

Objective: *This research is motivated by the low learning achievement of students in IPBA materials, especially in the cognitive domains of knowing, applying, and reasoning. This is based on the results of the TIMSS (Trends in International Mathematics and Science Study) survey in 2011, 2015, and 2019. Based on the results of observations, the ability to know, apply, and reason are abilities that are less facilitated in the IPBA learning process in the classroom. One of the learning alternatives that is seen as having ways that can train knowing, applying, and reasoning skills is learning with levels of inquiry (LOI). Therefore, the study aims to determine the contribution of the application of LOI in improving student learning achievement in the domains of knowing, applying, and reasoning.* ***Method:*** *The research design used in the study was a one group pretest-posttest design with a research sample of 35 students at one of the State Junior High Schools in Pandeglang Regency.* ***Results:*** *Based on data analysis using effect size, it was found that the effect size value of 0.75 in the knowing domain and 0.71 in the reasoning domain was in the medium category. Meanwhile, the effect size value of 1.32 in the applying domain is in the large category. This shows that the implementation of the LOI makes a moderate contribution to the improvement of the domain of knowing and reasoning. However, the LOI makes a significant contribution to the improvement of domain applying.* ***Novelty:*** *This research highlights the targeted use of Levels of Inquiry (LOI) to specifically enhance the cognitive domains of knowing, applying, and reasoning – domains often under-supported in IPBA learning – providing empirical evidence of its differentiated impact across cognitive dimensions.*

INTRODUCTION

Entering the XXI century, many things have changed fundamentally in various areas of human life. To deal with these changes, quality human resources (HR) are needed [1], [2], [3], [4], [5], [6]. In order to support the preparation of human resources to be able to face the XXI century well, careful attention is needed from education actors and policymakers in the government. One of the things that can be considered in determining education policy is the results of the TIMSS (Trends in International Mathematics and Science Study). TIMSS is a project of the International Association for the Evaluation of Educational Learning Achievement (IEA) based in Amsterdam, Netherlands. The objectives of the implementation of TIMSS as intended by the IEA [7] are,

> "…to provide political decision-makers in each country with the necessary information in identifying the weaknesses and/or strengths of their education systems, of domains requiring immediate intervention and also for the development of national strategies in the field of education".

Mathematics and science achievements in the implementation of TIMSS are categorized into two domains, namely the content domain and the cognitive domain. Meanwhile, the science content domain includes biology, chemistry, physics, and earth

and space sciences (IPBA). Meanwhile, the cognitive domain of science includes knowing, applying, and reasoning. Of the four science content domains in TIMSS, it is known that IPBA is the most difficult content domain for students to work on compared to the other three content domains. This is based on the science item analysis of TIMSS 2011 which places that IPBA or earth science has the lowest percentage of achievement compared to the other three content domains. The low achievement of IPBA in TIMSS also occurs in Indonesian students, even lower than the achievement of students in other countries as in [8], stating that:

"During the three periods Indonesia participated in the TIMSS survey, namely in 2011, 2015, and 2019 on earth science material, it was obtained that the average achievement of 34.77 was smaller than the international average of 42.56".

The low achievement in IPBA material, especially what happens to Indonesian students, is very unfortunate considering the importance of IPBA in physical science and life science as stated by the National Science Education Standards [9] that "Earth and Space Science as one of the eight categories of content standards along with Physical Science and Life Science".

The implementation of learning in IPBA materials is the most influential thing to the problems that have been described above. Based on the results of observations at one of the N Junior High Schools in Pandeglang Regency, it shows that with limited teaching aids and limited learning method alternatives, it causes a lack of facilitation of learning that can practice knowing, applying, and reasoning skills in IPBA materials so that it is possible to have an impact on low learning achievement in IPBA materials. Thus, more effective learning is needed to be able to improve student learning achievement in IPBA materials. One alternative learning approach that is seen as able to improve student learning achievement in IPBA materials is the inquiry approach. This is as the results of research conducted by [10] show that "Inquiry-oriented approach is more effective in enhancing learning of Earth science concepts than is a more traditional teaching method". Meanwhile, in the implementation of inquiry, [11] explained that inquiry must be delivered systematically so that the knowledge transfer process runs effectively. Furthermore, [12] introduces levels of inquiry in carrying out inquiry-based learning.

Levels of inquiry were developed to make it easier for teachers to teach science using inquiry through several levels that are tailored to students' thinking skills. The levels of inquiry as proposed by [11] have six levels, namely discovery learning, interactive demonstration, inquiry lesson, inquiry lab, real-world applications and hypotethical inquiry. The six levels in the levels of inquiry method are applied based on the intellectual abilities of students and the controller in learning. The higher the level of inquiry, the less guidance the teacher provides and the greater the students' control over learning.

There are several studies conducted related to the application of levels of inquiry in improving student learning achievement, including research conducted by [13] with the title "Profile of Inquiry Ability and Learning Outcomes of Vocational Students through the Application of Levels of Inquiry", conducted a study on vocational school students which showed an increase in the learning outcomes of students in the cognitive realm in

static electrical materials with a normalized average gain of 0.37 with Medium category. In addition, [14] with the title "Profile of Students' Inquiring Ability and Student Learning Outcomes After Applying the Levels of Inquiry Learning Model", conducted a study on junior high school students which showed an increase in learning outcomes of students in the cognitive domain in static electrical materials with a normalized average gain of 0.55 in the medium category.

From various studies related to the application of levels of inquiry that have been found, it shows that the application of levels of innuiry is proven to improve student learning achievement. Therefore, the researcher is interested in conducting research by applying levels of inquiry in improving the learning achievement of junior high school students in IPBA material with the research title, the application of the levels of inquiry method in improving student learning achievement in IPBA material

RESEARCH METHOD

In this study, to find out an overview of the improvement of student learning achievement after receiving treatment in the form of levels of inquiry, a pre-experimental method with a pretest-posttest group design was used. The research subjects were selected by purposive sampling at one of the State Junior High Schools in Pandeglang Regency. The selected research sample was 35 students. The implementation of research activities with a sample (student) applied the levels of inquiry method which was carried out three times with four levels out of six levels for each meeting. The four levels are discovery learning, interactive demonstration, inquiry lessons, and inquiry labs. After treatment, students are given a pre-test and a post-test.

The question test instrument is in the form of multiple choice with four answer options. The learning achievement test instrument consists of three cognitive domains, namely the domain of knowing, applying and reasoning [15]. Previously, the research instrument was judged by two expert lecturers and one junior high school science teacher and had also been tested on a number of students at one of the N Junior High Schools in the city of Bandung. The analysis of student learning achievement test data was carried out using the effect size equation (d) for independent-group post-test design.

$$d = \frac{\bar{x}_2 - \bar{x}_1}{\sqrt{\frac{{s_1}^2 + {s_2}^2}{2}}} \qquad \ldots 1)$$

Table 1. The effect size criteria.

≥0.80	Big
≥0.50 - <0.80	Keep
≥0.20 - <0.50	Small
≥0.00 - <0.20	Not Influential

Meanwhile, to see the implementation of the levels of inquiry, observation was carried out when the learning took place by three observers.

RESULTS AND DISCUSSION

Student learning achievement was measured using a written test in the form of a multiple-choice test with a total of 24 questions with details at the first meeting for the topic of solar and earth motion using a multiple-choice test of 13 questions, the second meeting for the topic of lunar phases using a multiple-choice test of 5 questions, and the third meeting for the topic of eclipse using a multiple-choice test of 6 questions.

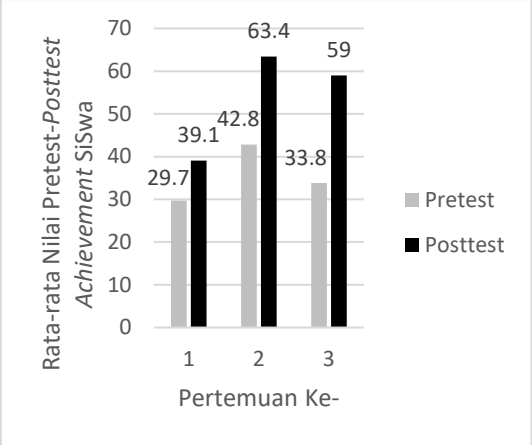

Figure 1. Average learning achievement score students at each meeting.

The contribution of the application of levels of inquiry in improving student learning achievement at each meeting is shown by the large effect size in Table 1.

Table 2. Effect size at each meeting.

The meeting	Effect size	Category Effect size
1	0,76	Keep
2	1,03	Big
3	1,18	Big
Average	0,99	Big

Based on Figure 1, it is known that the average pretest score obtained by students at each meeting is low compared to the average posttest score at each meeting. The low pretest results at each meeting are due to the lack of student knowledge related to the material contained in the pretest questions which have not been accepted by students through the learning process in the classroom at the junior high school level. However, after students were treated with the levels of inquiry method at each meeting, an increase in student learning achievement was obtained in each meeting which can be shown by comparing the results of the pretest-postet at each meeting.

At the 1st meeting, there was an increase in student learning achievement of 9.4 from the average pretest score. The increase in student learning achievement at the 1st meeting was the lowest increase in student learning achievement compared to the increase in student learning achievement at the 2nd and 3rd meetings. The contribution

of the application of levels of inquiry in improving student learning achievement at the 1st meeting can be shown by an effect size of 0.76 with a medium category. In line with the large increase in student learning achievement at the 1st meeting, the effect size at the 1st meeting was also the lowest compared to the other two meetings. This is suspected because the learning process does not run optimally, namely: not all stages of learning the levels of inquiry method can be carried out optimally by teachers and students as shown by the percentage of implementation of the levels of inquiry method at the 1st meeting of 92% which is the lowest percentage of learning implementation compared to the other two meetings. In addition, in the 1st meeting the material that must be delivered to students is more than the material that must be delivered in the other two meetings as can be seen in Appendix A.1. The more material in the 1st meeting caused not all material to be delivered optimally because there were some materials that took longer to be understood by students so that with limited time, there were materials that were not delivered optimally.

At the 2nd meeting, there was an increase in student learning achievement of 20.6 from the average pretest score. The increase in this 2nd meeting exceeded the increase that occurred in the 1st meeting. The contribution of the application of levels of inquiry in improving student learning achievement at the 2nd meeting can be shown by an effect size of 1.03 with a large category. The effect size at the 2nd meeting exceeded the effect size at the 1st meeting. This can happen due to several things: (1) there is an increase in the implementation of the learning stages of the levels of inquiry method at the 2nd meeting which is shown by the percentage of implementation of the learning stages by students of 98%; (2) The material presented is not as much as in the 1st meeting so that teachers can optimize the learning process by using the levels of inquiry method.

At the 3rd meeting, there was an increase in student learning achievement of 25.2 from the average pretest score. The increase in the 3rd meeting was the highest increase compared to the other two meetings. The contribution of the application of levels of inquiry in improving student learning achievement at the 3rd meeting can be shown by an effect size of 1.18 with a medium category. In line with the large increase in student learning achievement in the 3rd meeting, the effect size in the 3rd meeting was also the highest compared to the other two meetings. This can happen due to several things: (1) The learning stages of the levels of inquiry method at the 3rd meeting can be carried out by students very well which is shown by the percentage of implementation of 100%; (2) The material presented is not as much as in the 1st meeting so that teachers can optimize the learning process by using the levels of inquiry method.

Application of Levels of inquiry in Improving Student Learning Achievement in Each Cognitive Domain

The cognitive domains in this study include: knowing, applying, and reasoning. The three cognitive domains are distributed in 24 questions with a proportion of 8 knowing

questions, 9 applying questions, and 7 reasoning questions. In Figure 2. A profile of student learning achievement in each cognitive domain is presented.

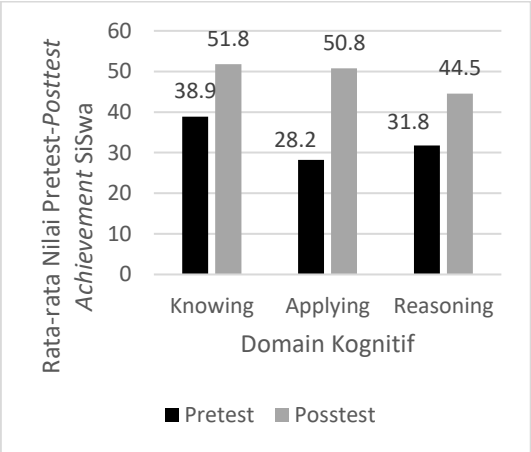

Figure 2. Average posttest pretest scores in each cognitive domain.

Based on Table 3, it was found that there was a difference in the order of average scores in the domain of knowing, applying and reasoning between the pretest results and the posttest results. This sequence shows the level of ease of working on problems from each cognitive domain. In the posttest, the cognitive domains that are easiest for students to answer, in order are the domains of knowing, applying and reasoning. Meanwhile, in the posttest, the domains that are easiest for students to answer, in order are the domains of knowing, reasoning and applying. In fact, the order of ease levels in the cognitive domain in order is knowing, applying and reasoning [15]. The difference in the order of the cognitive domains in the pretest and posttest results is suspected to be caused by the pretest work, students have minimal knowledge about the material being tested because it has never been delivered in class at the junior high school level and plus students are not used to doing TIMSS equivalent questions so it is possible that there are students who answer questions by guessing the answers. Thus, the sequence of cognitive domains in the pretest does not necessarily fully describe the ability of students to answer cognitive domain questions.

Meanwhile, based on the difference between the average score in the cognitive domain between the posttest and the pretest in Figure 4.5, it is known that the knowing domain has increased by 12.9 from the average pretest score, the applying domain is 22.6, and the reasoning domain is 12.6. This shows that there is a huge increase in the applying domain compared to the knowing domain and the reasoning domain. Thus, a deeper analysis is needed to find out the cause of the applying domain profile experiencing a huge increase compared to the knowing domain profile and the reasoning domain profile.

Analysis related to the greater increase in the average value of the applied domain compared to the other two domains, is important to trace the learning process. What can be reviewed in the learning process is the cognitive domain that is trained in the learning process through LKS. The domain of knowledge trained through the LKS facilitates

students to be able to identify the right science tools to be used in experiments (regocnize) and describe a nature, structure or phenomenon of science (describe). Meanwhile, the applying domain trained through LKS facilitates students to provide explanations of scientific phenomena by using science concepts (explain) and using diagrams or other models to describe science concepts (use models). Meanwhile, the reasoning domain trained through LKS facilitates students in making investigative procedures in science experiments (design investigation) and making conclusions based on observation and understanding of science concepts (draw conclusion). However, the work on the LKS on the implementation of levels of inquiry is only carried out at one of the four levels of inquiry, namely the inquiry lab. Meanwhile, the cognitive domains that are trained are also found in the other three levels of inquiry, namely discovery learning, interactive demonstration, and inquiry lessons so that the review related to the trained cognitive domain is not only reviewed in the inquiry lab, but must be at all levels of inquiry. Therefore, it is necessary to know the contribution of the application of all levels of inquiry during learning in improving student learning achievement in each cognitive domain which can be shown by the large effect size in each cognitive domain. Here is Table 3, which shows the large effect size on each cognitive domain.

Table 3. Effect size on each cognitive domain.

Cognitive Domains	Effect size	Category
Knowing	0,75	Keep
Applying	1,32	Big
Reasoning	0,71	Keep

Based on Table 3, it is known that the effect size of the knowing domain is 0.75 with the medium category, the applying domain is 1.32 with the large category and the reasoning domain is 0.71 with the medium category. This shows that the application of levels of inquiry makes a greater contribution to improving student learning achievement in the applying domain than the other two cognitive domains.

CONCLUSION

Fundamental Finding : Based on the data from the results of the research and also the discussions that have been carried out, it is concluded that the application of levels of inquiry can increase student learning achievement with effect size in the 1st meeting categorized as medium, the 2nd meeting in the large category, and in the 3rd meeting in the large category and the application of levels of inquiry can increase student learning achievement with effect size in the domain knowing categorized as medium, The applying domain is categorized as large and the reasoning domain is categorized as medium. **Implication :** The conclusion drawn from this study implies that consistent implementation of levels of inquiry in classroom instruction has the potential to significantly improve students' academic performance across different cognitive levels.

The varied effect sizes across domains and sessions indicate that inquiry-based learning not only enhances engagement but also supports differentiated learning outcomes, thereby affirming its relevance in diverse educational contexts. **Limitation :** However, while the findings clearly demonstrate the effectiveness of the levels of inquiry model, the categorization of effect sizes as only medium in the first session and in certain domains like knowing and reasoning suggests there may be contextual or instructional factors limiting its full potential. The study may also be constrained by the limited number of sessions and a specific student sample. **Future Research :** Future studies should explore the long-term impact of levels of inquiry over an extended academic period and across broader subject areas. Additionally, investigating the role of teacher readiness, student background, and classroom environment in mediating the effectiveness of inquiry-based approaches could offer deeper insights into maximizing its benefits.

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