Meta-analysis of the application inquiry learning models in physics classes

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Abstract. This research aims to analyze the inquiry learning model in the physics learning process. The samples of the study were 10 theses done by physics education students of Palangka Raya University. The theses were written by the students based on their research in applying the inquiry model in Palangka Raya Senior High School and in Junior High School. The theses were selected from among hundreds of reports based on the similarity topics started from the year 2015 until 2019. The method of this research is called meta-analysis, i.e., collecting the data from 10 selected thesis and analyzing them. To ensure the result, the researcher also carried out an interview with the students who wrote the thesis. The result of this meta-analysis research is that the inquiry learning model can improve student learning outcomes and also able to improve student skills such as Science Process Skills. However, the average score of the physics classes was still below the Minimal Achievement / Completeness Criteria, which is 75%. It was found from the interview that the low achievement score of the physics classes was likely due to the lack of experience in teaching as well as lack of mastering the inquiry model.

1. Introduction
The 21st century has had a significant influence on the world of education in Indonesia. The 21st century requires everyone to have the skills to compete in facing the changing times. That is what makes the government in Indonesia to change the learning curriculum, namely from KTSP to Curriculum 2013 (K-13). This in line with research conducted by Andrian, which shows that the implementation of the 21st-century learning process is classified as quite good using K-13 [1].

K-13 aims to encourage students to be better at making observations, have questioning skills, have reasoning power, and be able to communicate what is obtained and known after receiving learning material at school. K-13 is used in the learning process in schools with the help of a scientific approach or contextual approach, which expects students to have a balanced competency between cognitive (knowledge), affective (attitude), and psychomotor (skills) [2]. These three competencies are demands that must be met by schools in accordance with the K-13 provisions in the learning process.

Learning is a system consisting of various components that are interconnected with one another. These components include objectives, materials, and evaluation [2]. The learning process at this time is expected not to make students just memorize facts and general concepts of subject matter delivered by the teacher, but students are expected to be able to observe and learn process skills, problem-solving skills, and thinking skills when learning a knowledge [3]. Important elements in the learning process include students who learn, teachers who teach, learning materials, and the relationship between teachers
and students [4]. Teachers should pay attention to important elements in the learning process, especially in learning physics.

Physics is a part of Natural Sciences (IPA) which is developed through scientific steps to organize knowledge in predicting natural phenomena [5]. The important thing in learning activities in science learning, especially physics, is that students are active, so in this case the teacher must direct and encourage students to find their own knowledge. Teachers are expected to be able to master the teaching materials to be taught and also understand the situation of students so that they can teach according to the circumstances and students’ development. In order for the knowledge to be given to be accepted by students well, teachers are expected to be able to package Physics learning well, and one way is by choosing the right learning model.

The Learning Model is a plan or pattern that can be used to form long-term learning plans, design learning materials, and guide learning in class or otherwise [6]. The learning model can be in the form of a conceptual framework that writes systematic steps in organizing learning experiences to achieve specific learning objectives and serves as a guide for instructional designers and teachers in designing and implementing the learning process [7]. This means that each learning model serves as a teacher's guide to carry out the teaching-learning process. Each model used by the teacher in the teaching and learning process also determines the devices used in the learning. In accordance with the previous statement that physics learning requires students to be active in the learning process so that teachers in choosing a learning model should choose a model that can also make students active. One learning model that can make students more active during learning is the inquiry learning model.

The learning model inquiry a learning model that gives free space for students to find a passion and a way of learning, respectively. Students are no longer forced to learn in a certain style or way. Students are developed to become creative and productive learners. The positive value, students will not only know (know), but also understand (understand) the essence and potential development of certain learning materials [8]. Students who understand the material being studied are expected to have high knowledge competency values.

The inquiry learning model affects understanding, knowledge development on a topic, scientific process skills, attitudes towards learning, learning motivation, and communication skills. The general syntax of the inquiry learning model in the implementation of learning is as follows: presenting questions or issues, making hypotheses, data collection, interpretation of data, developing conclusions, and repetition.

Based on these descriptions, this study aims to analyze research related to the effectiveness of learning using the inquiry learning model on students' knowledge competencies. The analysis is viewed in terms of learning materials and research results. Like other meta-analysis research, this research is expected to be useful in the field of education, especially physics teachers in selecting appropriate learning materials and measuring student competencies if they apply the inquiry learning model in schools.

2. Method
The type of research used in this research is Meta-analysis. Meta-analysis is a research of several documents with similar research themes. Meta-analysis is also defined as research conducted by summarizing research data, reviewing and analyzing research data from previous research results [24]. Data collection in this research was carried out by tracing the thesis of students of the physics education study program at the University of Palangka Raya who applied the inquiry learning model. From the search, I obtained several theses and then randomly selected 10 theses with the category one of the variables seen is student learning outcomes.

Coding in meta-analysis is the most important requirement to be able to collect and analyze data [9]. Therefore, the instrument in this meta-analysis was carried out by presenting the code (coding category). It is intended that the variables used in research such as research name, educational level of research subjects, materials used in research, and research variables can be easily analyzed. After coding, data
analysis was carried out. Data analysis in this research used quantitative data analysis with percentages and qualitative data analysis for the data from the narrative study of the studies encountered.

3. Results and Discussion

3.1. Research Results
Researces on the application of the inquiry learning model were collected as many as 10 research results from students of the physics education study program, Palangka Raya University. The analysis was carried out based on the learning material and the research results obtained.

3.1.1. Inquiry Learning Model Based on Learning Material.
The relationship between learning models and learning materials is very important. Not all learning models are suitable for use in all materials, so in this case the teacher is required to be able to choose a model that is appropriate to the material to be taught so that the results obtained can be maximized.

The inquiry learning model requires students to be creative, collaborative, and active in the learning process [10]. The teacher plays an important role in packaging learning so that it can make students more active. Therefore, it is necessary to know the materials that have been tested using the inquiry learning model.

The learning model is a systematic step that serves as a guide for teachers in carrying out the learning process [7]. One important factor to be able to achieve maximum learning objectives is the suitability of the learning model used with the material being taught. Therefore, it is necessary to analyze the materials that have been used in the inquiry learning model as in Table 1.

| No. | Learning materials                  | Number of Thesis |
|-----|------------------------------------|------------------|
| 1   | Temperature and Heat               | 3                |
| 2   | Expansion of Substance             | 1                |
| 3   | Simple Plane                       | 1                |
| 4   | Light and Optical Equipment        | 1                |
| 5   | Pressure                           | 2                |
| 6   | Characteristics of Substances      | 2                |

Based on Table 1, it can be explained that of the 10 theses that were the research samples, there were variations in learning materials that used the inquiry learning model. The learning materials used are temperature and heat, expansion of substances, simple planes, light and optical devices, pressure, and substance characteristics. The materials most often used in research on the application of the inquiry model are temperature and heat materials. It can be seen from Table 1 that there are 3 theses that use temperature and heat material while the others are only 1 thesis, and for pressure material, there are 2 theses.

3.1.2. Results with Learning Model Inquiry
The learning model greatly affects student learning outcomes. The learning model is one of the things that the teacher guides during the learning process. Therefore, if the learning model used as a guide is not correct in its implementation, it can cause student learning outcomes to be not good either.

Results of the study of the 10 students theses of physics education at the University of Palangka Raya can be seen from the aspect of knowledge in the form of individual completeness, classical, and Special Learning Objectives. The results can be seen in Table 2.
Table 2. Analysis of Research Results (Knowledge Aspects)

| Essay | Completeness | TPK     |
|-------|--------------|---------|
|       | Individual | Classical |       |
| 1     | 64.10%     | 64.10%   | 76.67% |
| 2     | 77.78%     | 77.78%   | 72.22% |
| 3     | 65.38%     | 65.38%   | 65.55% |
| 4     | 78.78%     | 78.78%   | -      |
| 5     | 68%        | 68%      | 81.18% |
| 6     | 70%        | 70%      | 77.14% |
| 7     | 66.67%     | 66.67%   | 33.33% |
| 8     | 16%        | 16%      | 25%    |
| 9     | 70%        | 70%      | 51%    |
| 10    | 76.67%     | 76.67%   | -      |

Based on Table 2, it can be explained that the completeness of learning outcomes in the application of the inquiry learning model varies. The results of the existing research from 10 samples are in the form of completeness of individual, classical, and Special Learning Objectives learning outcomes. The highest completeness of individual and classical learning outcomes is 78.78% [11]. The highest completeness of specific learning objectives is 81.18% [12]. Meanwhile, the lowest completeness of individual and classical learning outcomes is 16%, and the lowest specific learning objectives as 25% [13].

Apart from being based on the knowledge aspect, 9 out of 10 research results were analyzed, measuring aspects of students' skills during learning. The skills measured include students' science process skills, psychomotor skills and student activities during learning. Research conducted by Juhji states that students' skills can be improved with the inquiry learning model [14]. The results of research data measuring aspects of skills can be seen in Table 3.

Table 3. Analysis of Research Results (Skill Aspects)

| Essay | Aspect of Skills | Research result                                      |
|-------|------------------|------------------------------------------------------|
| 1     | Science Process Skills | SB : 17.07%  |
|       |                   | B : 43.90%                                           |
| 2     | Science Process Skills | TB : 24.39%  |
|       |                   | STB : 7.32%                                          |
|       |                   | TH : 7.32%                                           |
|       |                   | SB : 71.43%                                          |
| 3     | Psychomotor       | B : 25%                                              |
|       |                   | CB : 3.57%                                           |
|       |                   | SB : 19.23%                                          |
| 4     | Science Process Skills | B : 21.62%  |
|       |                   | CB : 5.41%                                           |
| 5     | Science Process Skills | 81.65%      |
| 6     | Science Process Skills | 77%         |
|       |                   | - Conducting experiments and collecting data: 26.17% |
|       |                   | - Data analysis: 22.16%                              |
|       |                   | - Formulating problems: 13.33%                        |
| 7     | Student Activities | - Present: 12.50%                                    |
|       |                   | - Applying: 10.57%                                   |
|       |                   | - Listening: 9.72%                                   |
|       |                   | - Irrelevant behavior: 5.55%                         |
|       |                   | - Observe: 82.60%                                    |
| 8     | Science Process Skills | - Collecting Data: 76.54%  |
|       |                   | - Predicting: 65.45%                                  |
- Summing up: 60.37%
- Communicating: 62.94%

| Science Process Skills | Percentage |
|------------------------|------------|
| SB: Very good          | 78.18%     |
| B: Fine                |            |
| CB: Good enough        |            |
| TB: Not good           |            |
| STB: Not very good     |            |
| TH: Not present        |            |

Based on Table 3, it can be seen that with the inquiry learning model many student skills can be measured. The results obtained from several analyzed studies also varied.

3.2. Discussion

The results of the meta-analysis in terms of the suitability of the material with the model show that some materials are suitable for using the inquiry learning model. One of them is the temperature and heat material, which in the learning process can be carried out a lot of experiments. Experiments that can be carried out on this material include experiments on thermometers, heat transfer, black principles, and changes in form. At the level of understanding, students are able to state problems in their own words and are able to provide examples [8]. This fits with the inquiry learning model, which helps students to be active, collaborative, and creative in learning.

In general, the inquiry learning model is very helpful for the practicum-based learning process. The steps in the inquiry learning model lead students to be able to find their own knowledge and be able to carry out investigations. The steps of the inquiry learning model according to Bronnster are problem orientation, formulating problems, proposing hypotheses, planning experiments, conducting experiments, analyzing data, communicating, and concluding [15]. Therefore, materials that are suitable for using the inquiry learning model are materials that have sub-topics for conducting experiments and will greatly help improve student skills.

The research sample is part of the number of characteristics possessed by the research [16]. The sample in this research was a student’s thesis which was randomly selected related to the application of the inquiry learning model with the category one of variables seen being student learning outcomes. Educational research conducted in general tends to look at student learning outcomes or the level of achievement of learning competencies.

The application of the inquiry learning model can improve student learning outcomes. This is because the steps of the inquiry learning model guide students to be able to find and carry out investigations so that learning becomes more meaningful [10]. The average classical completeness of students increased after the application of the inquiry learning model was compared to before the learning model was applied [17–19]. Although classical completeness in the research analyzed, there are still many that have not reached the predetermined minimum classical completeness criteria, but when compared with classical completeness before this model is applied, the results obtained have increased. Many factors cause incomplete classical learning. These factors include that there are still students who are less active and less serious during the learning process, the lack of teachers in class mastery, and the inquiry learning model is a new learning model for students so that students still need adjustments [17–19].

The completeness of the Special Learning Objectives on the analyzed research results on average has a fairly good value, namely above 50%, there are only two research results whose ROR completeness value is below 50%. This is due to the fact that the evaluation questions given are quite good, although there are still some that still need to be improved. While the results of the research whose completeness
score was below 50% were caused by the evaluation questions compiled by the researchers were still not optimal so that many students were still confused in working on these questions. This is in line with research conducted by Widianie, which stated that one of the factors that caused the completion of specific learning objectives was that the instruments used were still not optimal to measure student learning outcomes [13].

The results of the research analyzed in addition to measuring student achievement in the cognitive aspects, also measuring student achievement in the aspects of skills. Juhji stated that by using the inquiry learning model, students’ skills can be improved [14]. The aspect of skills that is measured among others is Science Process Skills, there are 7 research results that measure, there is 1 research result measuring psychomotor skills, and student activity during the learning process there is 1 research result that measures.

The results of research that measure science process skills are 7 out of 10 research results. The average results obtained for science process skills are in the good and good enough categories. The results of Ramadany’s research and UI’s research showed that with the inquiry learning model, the value of science process skills was 77% and 78.18% in both categories [20,21]. This is because during the learning process there are still quite a lot of students who are active in carrying out experiments. The results of the research that measured psychomotor skills were 1 in 10 of the research results, and the results obtained were categorized as good, namely with a percentage of 76.92%. The results of the research that measured student activity during the learning process took place are there were 1 in 10 research results, and the results obtained were the activities of conducting experiments and collecting data to obtain the highest percentage value, namely 26.17%.

4. Conclusion

Based on the results of the meta-analysis in this study, it can be concluded that various studies on the inquiry learning model improve student learning outcomes. The highest completeness of individual and classical learning outcomes is 78.78%. The highest completeness of specific learning objectives is 81.18%. Meanwhile, the lowest completeness of individual and classical learning outcomes is 16%, and the lowest specific learning objectives is 25%.

The material used in the inquiry learning model is material that requires experimentation in the process of finding concepts such as temperature and heat. In addition to improving student learning outcomes, the inquiry learning model can also be used to measure student skills such as Science Process Skills when conducting experiments. The results of Ramadany’s research and UI’s research showed that with the inquiry learning model, the value of science process skills was 77% and 78.18% in both categories.

Research using the meta-analysis method will be more valid the results obtained if more journals or research results are reviewed. Therefore, suggestions for the future are to be able to add research results from both national and international journals related to the inquiry learning model so that the results obtained can be maximized.

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