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Problem Based Technology and Science Development to Improve Science Learning Outcomes in Elementary Schools

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Abstract: The purpose of this research is to describe the needs for teaching materials developed, elaborate the design characteristics of teaching materials developed, develop valid and effective learning media based on Problem Based Learning (PBL), and find the learning outcomes of style material among science students in class IV of Dukun State Elementary School, Karangtengah Demak District. This is a development research that uses 10 steps. The validation is carried out by two material experts and the results of effectiveness test is conducted on 50 students of grade four. The data is collected by using needs questionnaire, expert validation sheets, student learning outcomes and documentation. The data is analyzed by qualitative and quantitative techniques as well as t-test acquisition analysis to find the effectiveness of teaching materials developed. Results of the research will be the produce of science learning application with style materials. The use of teaching materials based on PBL and style material in class IV at elementary schools are expected can improve student's learning outcomes in the aspects of affective, cognitive and psychomotor.

Keywords: Teaching materials, Problem Based Learning (PBL), learning outcomes

1. Introduction

Indonesia's education quality is already characterized as low and stagnant (Arsendy et al., 2020). A study conducted by OECD (2019) shows that the performance of 15 year olds Indonesian students in the Programme for International Student Assessment (PISA) have not progressed much between 2003 until 2018. Meanwhile, World Bank (2016) estimates that only 5% of primary school teachers in Indonesia have sufficient teaching skills to increase their students' learning levels. The teachers also tend to use approaches of teacher-centered teaching more than student-centered teaching which leads to little meaningful student interaction (World Bank, 2015).

Therefore, teachers should select and apply appropriate teaching approach in order to facilitate the process of knowledge transmission effectively (Ganyaupfu, 2013). Student-centered teaching can help to encourage participation from students, increase students' motivation, improve communication skills and enhance students' learning outcomes. It is focusing on the needs, abilities, interests and learning styles of the students. One of the strategy in student-centered teaching is Problem Based Learning (PBL) (Dita et al., 2021). PBL model can develop student's creative abilities and problem solving (Wartono et al., 2018; Musna et al., 2021) by enforcing students to actively develop skills that are related to the learning outcomes (Fristadi & Bharata, 2015).

PBL was first applied by Howard Barrows in 1969 to solve the problems in the health sector, and then it was adopted in the school to improve learning outcomes (Bashith & Amin, 2017). PBL is a learning model that uses authentic problems as a context for students to think critically and solve the problem. The students are encouraged to collect information and data before making decisions in order to gain knowledge or experience. Barrows (1996) described the characteristics of PBL as problem based, problem solving, student centered, self directed learning and reflection.

There are few studies that assumes the implementation of PBL is an appropriate solution for student's learning outcomes. Permatasari & Anhar (2019) had developed a PBL module for subject Natural Science (MIPA) to be used by Grade XI students of Senior High School (SMAN 3) Kerinci. Their findings showed that the students who used PBL based modules had higher learning competencies by obtaining required knowledge, attitude and skills. Yuda et al. (2016) and Samroni et al. (2021) also found that PBL has significant effect on students' speaking competency by encouraging them to actively participate in finding the solution toward the problems.

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PBL also has been found can improve students critical thinking in physical science subjects in the sub-subjects Straight Lines Change Irregularly (GLBB) (Setyorini et al., 2011), student become more active within the classroom learning practices (Sunarti & Fadilah, 2019), and promote students' positive attitude toward courses (Demirel & Dağyar, 2016). According to Nargundkar et al. (2014), PBL model has positive impact on junior high school students by motivates learning and improve students' performance both in semester's final exam and group assignment. Besides that, PBL can improve students' ability to ask and answer from low to high thinking level (Nurdyansyah, 2018), help students explore their argumentative abilities successfully (Si et al., 2019), facilitates the development of togetherness in classroom setting (Ferreira & Trudel, 2012), and encourage and motivate students to learn to gain achievement (Zaduqisti, 2010).

In addition, a study by Sutrisna and Artini (2020) found that seventh grade students of secondary public school in Denpasar, Bali demonstrated better speaking performance and exhibited more positive behavioural, cognitive, and affective attitude toward English Language Learning (ELL) after being treated through PBL activities. Other researches on PBL models also stated its effectiveness in enhancing the ability and learning outcomes of students in subjects of Mathematics (Suparman et al., 2021), Geography (Sujiono et al., 2017), Science (Ersoy & Baser, 2014) and Chemistry (Amir, 2010). This concludes that the right learning model is important for the success of learning process.

Learning model is essential to increase the learning outcomes in teaching and learning process by giving solution about the weakness and deficiency of teaching and learning in the classroom (Risnawati et al., 2019). According to Moravec et al. (2010), the use of model and strategy of learning can actively increase the learning outcome in the classroom. Permatasari et al. (2019) suggested PBL as an alternative for learning which is more innovative, fun and challenging for students to build their own knowledge by solving problems that are similar to the real world. Each learning model used to support and assist the learning process certainly has a very important impact on improving the ability of each student (Faqiroh, 2020).

However, PBL may bring advantages and disadvantages. According to Wee Kek (Amir, 2010, p.32-33), the advantages of PBL are the activities can build prior knowledge, metacognitive and constructive thinking, increase interest and motivation in learning, and targeted material can be covered. Saleh (2013) and Muhamad et al. (2021) said problem based learning is a suitable model for junior high school students in their lessons related to problem solving skills by making students discover new things, increasing students' activeness during lesson, helping students to apply academic knowledge to solve real life problems, and improving students' cognitive abilities, and scientific competence. Meanwhile, the shortcomings of PBL includes of difficulty in finding relevant problems, complex learning preparation (problems and concepts), and requires long time in educational process (Trianto et al., 2021).

2. Methodology

During Covid-19 pandemic, the researchers are considering to collect data by using scheduled alternating normalization techniques, namely scheduling class IV students alternating with 10 children to go to school alternately in duration of one hour. This research is conducted in compliance with health protocols by wearing mask, keeping social distance, using hand sanitizers and always washing the hands. The Covid-19 pandemic seems will not end immediately at Indonesia, so the people must be prepared with the new norm (Fachriansyah, 2020). This research uses data collection and data analysis techniques by qualitative and quantitative.

2.1 Research Design

The research uses pre-experimental design. This is not a serious experiment because there are other variables that influence the formation of the dependent variable. The type of pre-experimental design used is one group pre-test post-test design.

2.2 Research Procedure

Due to time constraints, research and development design is used with ten implementation steps by referring to the theory of Borg and Gall. According to Borg and Gall (Sugiyono, 2013, p.409), research and development (R&D) is a research method to develop or validate products used in teaching and learning. Postholm (2011) states that the term R&D work indicates that there are at least two processes occurring at the same time which good practices are explored and developed. The systematic approach means that the researcher's insight is focused on activities in practice. It is the insight that represents the systematic part of learning. This research will be conducted in ten stages of research.

2.3 Data Sources

Data sources used in the development of research-based teaching materials PBL for student's grade IV elementary school include the subject and trial design describes as follows:

2.3.1 Subject Trial

The source of data on research and development is 30 students of class IV Shamans State Elementary School and Kedunguter State Elementary School Karangtengah Demak as experimental class and 30 students of class IV Wonowoso State Elementary School number 1 and Wonowoso State Elementary School number 2 as control class. Meanwhile, research development of teaching materials based on PBL is for class IV Sampang State Elementary School number 1 Karangtengah Demak.

2.3.2 Trial Design

Test design products that are used in the research development of teaching materials based on PBL for students of classes IV Elementary School is pre-test post-test control group design.

2.4 Types of Data

The types of data collected from this research comes from needs analysis data, validity data and effectiveness data. The first is data analysis of student and teacher needs. Second, the data on the feasibility of teaching materials are obtained from the results of expert validation by providing input for the improvement of teaching materials before they are tested. Third, the data on the effectiveness of teaching materials are obtained from the results of the increase in the value of learning outcomes which shows more than 75% of students completed individually with Minimum Completeness Criteria (KKM) 75. From this several types of data, it can prove that the results of the development of only materials based on PBL for grade IV Elementary School students are suitable to use. The data are collected by quantitative and qualitative techniques.

2.5 Research Instruments

Three instruments are used for data collection as follows:

a) Needs Questionnaire Sheet
   The needs analysis sheet contains questions about what learning model to achieve, the teaching materials used, and evaluation of learning related to the material in the sub-theme book on Ethnic and Religious Diversity in My Country.
b) Learning Media Validation Sheet
   This instrument contains statements that will be rated by the expert. The validation sheet contains aspects that must be fulfilled in the learning media along with their scoring which includes of content or material feasibility, linguistic, presentation, and graphics. Each aspect includes the several points of assessment regarding the development of PBL teaching materials.
c) Sheets of Learning Media Effectiveness Test Instruments
   The teaching material effectiveness test instrument is used to collect data on student learning outcomes in the form of pre-test results (before the provision of teaching materials developed) and post-test results (after giving the developed teaching materials). This instrument contains 20 multiple choice questions with four answer choices that have been empirically validated.

The instruments on research-based teaching materials development PBL for learning outcome sub-theme earth, sun and moon is used at elementary school. Meanwhile, the instrument on the needs of teaching materials based on PBL for learning outcome sub-theme Ethnic and Religious Diversity My Country is used at Elementary School.

2.6 Data Validity Test

Quantitative and qualitative data are collected in this research. The needs questionnaire sheet contains the questions of what learning model to achieve, the teaching materials used, and evaluation of learning related to material in the earth, sun and moon sub-book. The material expert validation sheet is given an assessment by the material expert, while the media expert validation sheet is given an assessment by a media expert. The questionnaire which given to students aims to obtain data about the practicality of using teaching materials. Observation guidelines are used to observe the learning implementation process whether it is as planned or not. The instrument for testing the effectiveness of teaching materials is used to collect data on student learning outcomes. The required data will be collected. So, the researcher is expected to organize and systematize the data so that it is ready to be used as material for analysis.

The test analysis technique to be used in this development research includes the validity and reliability of the questions. The product development effectiveness test is carried out by the experimental class students. Researchers are testing the effectiveness of the product by using differences in pre-test post-test results. Preparation of pre-test or post-test questions must consider the level of thinking and adjusted according to the learning objectives. The effectiveness test is carried out by using the N-gain test. The results are interpreted by the gain (g) classification interpretation table. Hypothesis testing involves two population groups and t-test is used. If reliability and validity tests produce

different data, the researchers must conduct further discussions pertinent to the data source or the other, to ensure the data is correct.

2.7 Data Analysis

Data analysis technique is the activity of compiling and presenting research data obtained through research results. Data analysis is needed to test the correctness of the research hypothesis. Prototype needs data analysis, validity and effectiveness analysis are used to test data on needs, the level of validity and effectiveness of teaching materials.

2.7.1 Data Analysis of Learning Media Development Needs

Data analysis is performed by determining the characteristics perceived needs of teachers and students by determining the percentage of answers to each item question or statement. This means that each item in the respondent's answer will be calculated. The highest frequency is taken into consideration as a description of the respondent's will in each question item. These results must be considered in developing prototypes of teaching materials.

2.7.2 Analysis of Test Data Validity

The data is obtained from the result of assessment of learning media development. The prototype of teaching materials is presented to the experts together with the assessment sheet. The results will then be analyzed the percentage based on the score obtained on each assessment item. This is done by knowing the value of each statement item, the value is accumulated and the average score is sought.

Based on the average results, it can be seen the condition of the teaching materials developed. If results of the assessment of two experts show that the teaching materials are in still sufficient and insufficient category, it means that the development product must be revised according to the experts' suggestions. If the research results have reached good or very good category, the product will be corrected only for the aspects that are assessed as not good.

2.7.3 Analysis of Learning Media Expert Validation Test Data

There are two steps to determine the feasibility of teaching materials which described as follows:

a) Recapitulate the data on the feasibility of teaching materials into a table that includes the aspects, indicators and values for each validator
b) Determine the average value of all validator validation results for each indicator by using certain formula

2.8 Test Analysis Techniques

The test analysis techniques in this development research are includes of testing the validity, reliability, difficulty level and distinguishing power of the questions. Mudjijo (1995, p.41) explains that one of the most important types of validity that every learning outcome test must have is content validity. A learning outcome test is said to have high content validity if the test is able to measure representative sample of the subject matter given, and behavioral changes that are expected to occur in students. To fulfill this requirement, the preparation and selection of test items should be based on these two things. Therefore, test layout is required as a guideline for compiling and selecting the test items in question.

Research on the development of PBL teaching materials is said to be successful if it fulfills the following matters:

a) The learning media based on PBL for grade IV Elementary School is developed in accordance with the results of analysis of the needs of students and teachers
b) The characteristic design of media learning based on PBL for student's grade IV elementary school which serves learning sub-themes of the earth, sun and moon is developed based on the principles of instructional media development and the results of needs analysis
c) The development and use of learning media based on PBL for grade IV Elementary School meets the eligibility criteria according to the validation results from the experts and practitioners
d) The learning media based on PBL for grade IV Elementary School fulfills the effective criteria with more than 75% of students completing individual studies with Minimum Completeness Criteria (KKM) 75 tested with post-test questions

3. Conclusion

Learning outcomes is a variable that depends on teaching materials, teachers and students. Its success can be measured through domains cognitive, affective and psychomotor. It is necessary to develop teaching materials that able to facilitate students to master their knowledge and upgrade the skills. The teachers shall explore the goodness of PBL as part of teaching materials and develop an effective module for better learning outcomes. A good PBL model certainly can attract students' interests, enhance their participation during teaching and learning session, and stimulate them to

think critically. These will lead to the success of learning outcomes and better grade or achievement among the students.

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