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DEVELOPMENT OF SCIENCE LEARNING DEVICES IN THE TOPIC OF THE SCIENCE OBJECT AND ITS OBSERVATION

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Abstract:
2013 Curriculum Learning requires an educational process that provides opportunities for students to develop all their potential. For this potential to develop well, the teacher must be able to position himself as a guide and facilitator for students. The low level of critical thinking skills of students results in the slow development of potential within students. Therefore, efforts need to be made by the teacher to help students in developing critical thinking skills. One effort that can be done is to develop a learning tool that is expected to be able to improve critical thinking skills by applying a guided inquiry learning model. Research on the development of learning devices aims to produce integrated learning tools that are valid, practical and effective. The development research method follows a procedural development model at the preliminary research stage and applies the Mafumiko design at the formative evaluation stage. The development research subjects were experts, partner teachers, and seventh-grade students of SMPN 22 Banjarmasin, academic year 2017/2018. Data analysis was carried out descriptively through a categorical system. The results showed that: 1) the validity of the device based on expert judgment fulfilled the valid category, readability of teaching materials, LKPD and item items included in the good category, 2) the practicality of learning devices fulfilled the good category, and student responses were very positive, 3) the effectiveness of learning devices shown from the increase in cognitive learning outcomes and improvement of students critical thinking skills.

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Psychomotor performance, teacher activity, and student activities fulfill good categories.

Keywords: learning devices, validity, practicality, effectiveness, inquiry guided

1. Introduction

Meaningful learning can be built by paying attention to the cognitive structure of students so that it will be long-lasting in memory/memory (reconstruction occurs), the way with guided learning, is not just a transfer of knowledge (Kosasih, 2014). In this case, learning is not only carried out by the teacher but is student-centered so that students get the opportunity and experience to obtain information, solve problems and make their own decisions. For this reason, an ability that can train students thinking skills is needed.

The results of the 2011 PISA and TIMSS study show that the ability of students in Indonesia is still low, especially the implementation of scientific literacy (Wasis, 2015). This means that the average critical thinking ability of students in Indonesia is still low, therefore as educators need to think about ways to make students have critical thinking skills. The challenge for teachers as educators is to understand learning strategies so that these skills can be possessed by students. Educators must continue to improve their abilities as facilitators in learner-centered learning.

Based on observations in the field, the learning outcomes of science students are still low. Many things cause this to happen. One of them is the unavailability of good learning devices so that they can improve student learning outcomes. The learning devices available are only in the form of separate syllabus and RPP so that their use is not practical. Besides, most teachers cannot apply learning models that can arouse the activities of students in the classroom.

Learning models that can be applied in the scientific approach to the 2013 curriculum include Problem Based Learning, Project-Based Learning, and Discovery Learning. Discovery Learning has the same principles as Inkuri. Some results of research on the application of inquiry learning models show the effectiveness of the learning process and the improvement of students' critical thinking skills.

It is necessary to develop valid learning devices, which can be implemented by the teacher (practical), to develop critical thinking skills and learning processes that delight students (effectively). One topic in class 7 is the science object and its observations. The study was conducted at SMP Negeri 22 Banjarmasin because of the low intake of students, especially science subjects.

2. Methods

This study uses a procedural model consisting of 6 phases, divided into 2 stages, namely the stages of conducting a preliminary study (identifying problems, describing objectives, designing and developing RPP) and stages of making prototypes (individual testing and validation by experts, small group testing, field testing). The research sample includes the one to one stage for 3 students, a small group of 10 students, and a parallel test phase for 3 test classes. Practical factors are reviewed from the content validity and the implementation of learning activities and responses of students. The effectiveness factor is oriented to the results of the learning process. The data obtained is related to the practicality and validity of the device development results processed categorically. Whereas data relating to effectiveness is processed in percentages.

3. Results

3.1 Results of Validity, Practicality, and Effectiveness

The stages of preliminary research carried out the process of developing devices with results in the good and proper categories to be used with a variety of minor revisions in several parts, especially in the use of scientific vocabulary that students may not have known much. Learning devices are also in a good category on the readability of students with positive feedback. The implementation of learning activities is supervised directly by 2 observers. Implementation of RPP with guided inquiry models with observations starting from preliminary activities, core activities, to closing activities during the small group stages and field testing in good categories. The response of students to learning with guided inquiry models was obtained from small group tests and field tests. Based on the results of the questionnaire the conclusions of the students' responses to the implementation of guided inquiry learning conclusions were very positive because for most students the application of this model was new and very memorable for them. This shows the level of practicality of learning has been fulfilled.
Data effectiveness of this learning device is concluded from data on student learning outcomes, assessment of critical thinking skills, observation of teacher activities and student activities, and assessment of psychomotor skills. Data on student learning outcomes are obtained from the answers of students in solving cognitive problems after students pass the learning process using a guided inquiry model. The minimum completeness criteria set by the school are 72, and the classical completeness criteria are 70%.

The completeness of learning after going through a guided inquiry learning process shows an increasing trend. The completeness in the small group phase is around 83% and in the field test around 72%. From the three field tests, we have obtained data that each group has classically met the completeness criteria even though the mean value after the post-test is not too high. The increase in the average value of students in field test 1 was 49.25%. Infield test 2 there was an increase in the average value of 44.56% and field test 3 an increase in the average value of 50.75%. Thus it can be concluded that the devices that we have developed are effective from the components of learning outcomes of students.

A. Observation Results of Students Critical Thinking Skills

Data on the assessment of critical thinking skills are collected from the observation and assessment of the results of the students' worksheets which contain instruments for assessing critical thinking skills. In the large group test (field test) carried out in three field trials with five meetings in each field test session. The following are data on the results of successive critical thinking skills from the first to the last field test session.

Table 1: Field Test 1

No.	Indicator	Persentage (%)				
		P 1	**P 2**	**P 3**	**P 4**	**P 5**
1	Formulate problems	62,50	62,80	67,86	72,02	76,19
2	Formulate a hypothesis	69,17	72,92	78,33	82,50	86,67
3	Designing experiments	69,58	72,08	77,50	85,00	87,50
4	Collecting data	69,44	70,83	77,78	79,86	76,39
5	Analyze data	69,58	72,92	80,83	84,58	89,17
6	Formulating conclusions	71,53	72,22	75,69	77,78	85,42

Category: Adaptation from Akbar (2013): 85≤100% (Very Good); 70≤85% (Good); 50≤70% (Less Good); ≤50 (Not Good).

Table 2: Field Test 2

No.	Indicator	Persentage (%)				
		P 1	**P 2**	**P 3**	**P 4**	**P 5**
1	Formulate problems	67,53	71,43	74,03	79,87	76,19
2	Formulate a hypothesis	74,55	75,45	75,45	85,45	86,67
3	Designing experiments	70,00	71,82	78,18	79,55	87,50
4	Collecting data	70,72	71,82	75,67	80,23	76,39
5	Analyze data	72,27	79,09	79,55	83,64	89,17
6	Formulating conclusions	75,00	76,52	81,82	91,67	85,42

Category: Adaptation from Akbar (2013): 85≤100% (Very Good); 70≤85% (Good); 50≤70% (Less Good); ≤50 (Not Good)

Table 3: Field Test 3

No.	Indicator	Persentage (%)				
		P 1	**P 2**	**P 3**	**P 4**	**P 5**
1	Formulate problems	67,43	68,00	71,43	72,00	73,71
2	Formulate a hypothesis	72,00	73,60	77,60	80,80	85,60
3	Designing experiments	73,20	79,60	81,20	83,60	87,60
4	Collecting data	72,33	73,67	75,67	77,33	78,67
5	Analyze data	81,20	80,80	82,00	83,60	88,80
6	Formulating conclusions	79,33	80,67	81,33	82,67	82,67

Category: Adaptation from Akbar (2013): 85≤100% (Very Good); 70≤85% (Good); 50≤70% (Less Good); ≤50 (Not Good)

B. Student Psychomotor Observation Results

Data from the skills or psychomotor observations of students were obtained through observations in all field test groups. The performance assessed is the student's skills in using a microscope as a tool used for observing microscopic objects. In this case the use of a microscope for observation using finished preparations. A summary of psychomotor performance assessment data can be seen in the following table.

Table 4: Summary of Results of Psychomotor Performance Assessment in Field Test

Class	Mean (%)	Category
VII A	75,12	Good
VII B	81,94	Good
VII C	79,00	Good

Category: Adaptation from Akbar (2013): 85≤100% (Very Good); 70≤85% (Good); 50≤70% (Less Good); ≤50 (Not Good)

4. Discussion

4.1 The Validity of Learning Devices

Criteria for determining validation by experts at the initial session and panel sessions on learning devices developed adapted Heinich criteria (Nur, 2014). Recommendations are given by experts on learning devices in the form of categories with criteria that are good or need improvement. Mafumiko (2006) states that expert assessments aim to explore the validity of the material, which is obtained by gathering the opinions of experts experienced in pedagogy and the development of curriculum material.

The assessment of the validity of the learning device was made descriptively based on the recommendations of experts consisting of two criteria namely Good (SB) and Needs Improvement (PB). In stage I (initial session) several components still need improvement (PB) based on the results of expert review. The study of learning devices that have been carried out by 3 education experts at the panel session produces a valid learning device (prototype). The validity of a device is an absolute requirement in development research even though it must go through several revisions so that there is a high-quality guarantee at each microphase (Ploomp and Nieveen, 2007).

After the draft of the device is improved based on the results of the review and suggestions from the experts, it is produced the SMP Science learning device on the topic of the Science Object and its observations are declared valid. Plomp states that validation studies are focused on designing one or more learning environments to develop and validate theories about the learning process and how learning environments can be designed (Akker, 2007). Nieveen and Akker (2007) concluded that the validity of product learning devices that have been designed is based on the statements of knowledge experts in their fields. Learning devices that have been compiled have also passed the formative evaluation phase that has been implemented so that it becomes an effective, efficient, interesting/motivational, learning tool that can be used and can be accepted (Tessmer, 1998).

This device development research is supported by the results of the study of Zaini (2016) who also applied the Mafumiko design to produce valid learning devices. Normala (2017), with different learning topics, has also researched the development of learning devices that adapt Mafumiko's design and have produced valid learning devices. The observation component of the readability of teaching materials and LKPD also meets the good category, meaning that the teaching materials and LKPD that have been prepared can be used/used properly by students. This component supports the intervention process to make revisions to the learning device development process until a valid device is obtained.

Readability test results on teaching materials, LKPD, and items obtained at the individual test. Readability tests conducted by three students received a positive response and met the good category. The results of Zaini, et al. (2018) state that the effectiveness of teaching materials can improve critical thinking skills. Tessmer (1998), states that the individual test of students at the same time with experts before the product trial is intended to obtain input material to revise the learning device. Tessmer (1998), also states that individual evaluations of students are very well done to identify the existence of errors and problems contained in the initial draft of the learning device. Individual students can act as critics to evaluate the initial draft of the learning device.

4.2 Practicality of Learning Devices

Practicality according to Tessmer (1998) means that it is easy to use by users, and can be given and used by all students. Jaya, et al., (2014) stated that observer's observations of the implementation of the RPP in learning and the responses of students to student books could be used as indicators to assess the practicality of the learning devices developed. The practicality of a learning device can be measured by observing the results of the recapitulation of the implementation of the Learning Implementation Plan (RPP) conducted by 3 partner teachers in the field test. Observations were carried out by two observers. In addition to the feasibility of the lesson plan, the response of students to learning that implements a guided inquiry model also determines the practicality of a learning device.

Learning devices on the topic of Science Objects and Observations developed by applying inquiry learning models, in general, have met the good category that can be used or implemented well by partner teachers. From the data that has been stated previously, we can know that the average value of RPP implementation in preliminary activities, core activities, and closing activities is classified as good with the mean for the three field test groups gaining a score of 3.81 (Nur, 2014). Such results indicate that learning has taken place by the plans contained in the RPP. Sudjana (2011) writes that the ability demanded in the teaching and learning process is the activeness of the teacher in creating and growing learning activities by the plans that have been prepared.

According to Nieveen (2007), the criteria for the practicality of learning devices are fulfilled if products that have been designed and developed can be used easily for teachers and students. The results of students' responses to learning by implementing a guided inquiry learning model showed a positive response. According to Hidayati and Heryanto (2013), the response is an impression or reaction after we observe sensory activity, judging, an object. The formation of attitudes towards the object can be either negative or positive. The responses of students for the three groups of field tests showed a very good response with an average of 49.57% and those who strongly agreed 47.71%. This shows that almost 97% of students respond very well to learning by applying a guided inquiry model. And in general from the results of observations very visible enthusiasm of students when the learning process takes place. This is in line with the opinion of Kusnandar (2011) who wrote in his book that guided inquiry learning encourages students to learn through their active involvement with concepts and principles, and the teacher encourages students to have experience and conduct experiments that enable participants students to find principles for themselves.

The results of observations of students' responses to the implementation of guided inquiry learning models are also supported by the results of the Nursafiah (2015). The results of Nursafiah's research state that students' responses to the application of guided inquiry learning models to photosynthetic material are very pleasant because abstract concepts can be proven through practical experiments so that there is an increase in mastery of concepts.

4.3 Effectiveness of Learning Devices

The effectiveness of a learning device can be measured by observing the results of the data on student learning outcomes, observing critical thinking skills, psychomotor observations, partner teacher activities, and student activities during the learning process in the three field test groups.

The three field test groups we have obtained data that the results of cognitive assessment in each group of field tests have classically met the criteria of completeness even though the mean value after the post-test is not too high. The increase in the average value of students in field test 1 was 49.25%. In-field test 2 there was an increase in the average value of 44.56% and in-field test 3 an increase in the average value of 50.75%. Thus it can be concluded that learning devices that apply the guided inquiry model that we have developed are effective from the components of learning outcomes of students. The results of this study are supported by several research results that have been conducted by other researchers before.

The research results of Wahyuni, et al. (2016) state that the application of guided inquiry learning models with experimental methods can provide better learning outcomes compared to classes that use conventional learning models. Udiani, et al. (2017) conducted a similar study by applying a guided inquiry learning model which showed that the increase in the average learning outcomes of science was greater than the increase in learning outcomes with the application of conventional learning models. The results of this study are in line with the results of Iswatun, et al. (2017) who conducted a study on the application of guided inquiry learning models to improve PPP and learning outcomes of class VIII middle school students. The results of his research indicate that the application of a guided inquiry learning model can improve student learning outcomes.

Data on student's critical thinking skills shows us that the average critical thinking skills of students in each field test group, in general, have met the criteria of good. Both on each indicator and classically. However, if we look more closely, it can be seen that the lowest average is in the skill of formulating problems. This happens because of the lack of ability of students in terms of composing a question sentence that is related to observations that have been made to an object. According to the learning theory proposed by Piaget that at the age of 11 years is a stage of formal operation where children have begun to learn to think abstractly. But what happens, in this case, may still need guidance from a teacher to further train his critical thinking skills, especially in preparing a sentence formulation of the problem based on observations.

The low skill of students in terms of formulating sentence formulation problems at the beginning of the meeting as happened in a small group test where students still need time to adjust to the new learning environment. This is by what was stated by Piaget (Sagala, 2011) which states that when a person develops into adulthood he will experience biological adaptation to his environment. Then there will be an assimilation process or a process of adjusting or matching information that has just been obtained with prior knowledge. In addition to the assimilation process, children also experience an accommodation process where at this time someone will arrange and rebuild prior knowledge so that new knowledge can be adjusted accordingly.

As time went on, the next meeting had seen an increase in critical thinking skills even though the increase was not striking. The improvement of student's critical thinking skills in the three field test groups was also supported by the results of Mustachfidoh (2014) which showed that inquiry learning models emphasized the activities of students finding concepts and developing the ability to think systematically, logically and critically.

Similar research was also conducted by Falahudin (2016) who examined the effect of guided inquiry learning models on critical thinking skills which concluded that guided inquiry learning models influenced student's critical thinking skills. The results of the study by Fadillah, et al. (2015), concluded that inquiry-based learning was able to improve critical thinking skills and collaboration of students. The ability to work together will make it easier for students to communicate and collaborate during learning activities. It also makes it easy for groups of students to collect, manage, share and present the data they find to compile reports on project tasks in groups. Observation of student activities shows good categories. Overall, from the three groups of field tests, it can be concluded that during the learning process the activities of the students, in general, take place in a good category. Activities of students are observed when the learning process takes place.

The activity of students is very prominent when they discuss, make observations, and conduct experiments. This will support them to get as much information as they can about the things they are learning. The activity of these students shows us that they like how to learn with this model. This confirms the opinion of Hosnan (2014) which states that one of the principles that must be applied to improve the quality of learning is to create pleasant and challenging learning conditions. The research results of Mustachfidoh (2013) also support this research that the application of inquiry models emphasizes the activities of students to find concepts and develop the ability to think systematically, logically and critically.

The activity of students in the class is also facilitated by how the activities of the teacher in building a good learning condition when the learning process takes place in the classroom. Psychomotor Performance Data describes a summary of the activities of three partner teachers in all three field test groups. The data is obtained from observation during the learning process. From these data, it can be concluded that the activities of partner teachers during the learning process take place have met good categories (Nur, 2014). This means that the partner teacher's activities in implementing inquiry learning in the field testing group are good and by the standards of learning implementation with predetermined indicators. In this case, the teacher has acted as a good facilitator to maintain the involvement of students in the learning process. Therefore students remain student-centered during the learning process. Such conditions will further allow students to train their skills to be able to find their concepts. This is by the opinion of Hosnan (2014) who stated that the 2013 curriculum adheres to the basic view that knowledge cannot be simply transferred from the teacher to the students. Students are objects that can actively search, process, construct and use their knowledge. So that with these ability students gets more meaningful learning. Like Ausubel's learning theory (Dahar, 2011) which classifies learning into two dimensions. The first dimension relates to how information or subject matter is presented to students and the second dimension concerns how students relate the newly acquired information to existing knowledge. The ability to link good information with pre-existing information makes learning more meaningful.

This is also supported by how the teacher's activities in utilizing teaching materials and learning media are used in the learning process. Teaching materials and learning media are used to facilitate the teaching and learning process. Teaching materials and interesting media can function as a stimulus for students so that they can provide good responses during the learning process. This is related to the learning theory proposed by Thorndike (2009). According to Thorndike, learning is the process of interaction between stimulus and response. The stimulus is what stimulates learning activities such as thoughts, feelings, or other things that can be captured through sensory devices. While the response is a reaction that is raised by students when learning can also be in the form of thoughts, feelings, or movements/actions. Thus it can be said that if the teacher can use teaching materials and learning media well, students will be motivated in learning.

The importance of learning motivation was put forward by Schaal, et al. (2012) in his research that the development of inquiry-based approaches applied in the learning of the topic of Biodiversity and supported by the use of the latest communication service technology showed excellence in the field of motivation and cognitive learning of students tested. To create a meaningful learning environment, teachers are deemed necessary to present learning related to the lives of students through several methods that are considered appropriate.

Other components that contribute to the effectiveness of a learning device as a result of development (prototype) are the existence of data from observations of psychomotor performance. In this learning tool, the assessment of psychomotor performance is observed from the students' skills in using a microscope as a tool to observe microscopic-sized objects. Based on data from psychomotor performance assessment results, it can be seen that in general students already have the ability to use a microscope and meet good categories (Akbar, 2013).

The psychomotor performance assessment of students in the field test group was conducted to train students' skills in the use of microscopes. The finished preparations provided in this observation vary, to give students the freedom of microscopic objects they want to observe using a microscope. This skill assessment data collection was assisted by two observers who directly assessed the student's skills in using a microscope. Based on information obtained from students said that they had never used a microscope before. This is their first experience. It is clear that students are very enthusiastic and motivated to learn to use a microscope until students find themselves in the shadow of the objects they observe, even though this is the hardest part of learning to use a microscope. The tenacity of students to find the shadow of objects they observe becomes a big boost so that they can see and find the shadow of objects. This motivation is something that wants to be built from students so that they have a great curiosity in learning science as one branch of science. This motivation is expected to be able to change the attitude of not happy to be happy with science lessons.

A great desire in students to be able to see/observe the shadow of objects under a microscope resulted in the learning process with this model of inquiry takes a longer time. This is by the opinion of Rusyan (1999) which states that the weakness of the inquiry model is time-consuming. To minimize these weaknesses, a teacher must have a good time management strategy during the learning process.

5. Conclusion

Based on the results of the research, the Development of the Junior High School Learning Tool at the Science Object Topic and its observations obtained the following conclusions.

1) This development research produces a product in the form of an integrated learning device prototype for the Science Object Topic and its observations which are equipped with teaching materials, LKPD and cognitive assessment along with the key.
2) The junior high school science learning tool on the topic of science objects and their observations results in a device that is valid, practical and effective.

3) The advantages of the prototype resulting from this development have used the scientific approach with inquiry-based learning according to the demands of the 2013 curriculum.

5.1 Recommendations

1) Products developed by this research can be used by science teachers as well as possible to facilitate teaching in schools because they already contain learning scenarios that are systematically made.
2) The teacher can develop learning tools similar to different topics so that they can complement each other learning tools that have been developed by other researchers.

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