

The Development of Science Teaching Materials Based On Practicum in Applying Motion Energy Concept Topic

Desi Wulandari
*Departement of Elementary School
 Teacher Education, Faculty of
 Education, Universitas Negeri
 Semarang, Semarang, Indonesia*
 Email: wulanipa@mail.unnes.ac.id

Ana Rosiana
*Departement of Elementary School
 Teacher Education, Faculty of
 Education, Universitas Negeri
 Semarang, Semarang, Indonesia*
 Email: anarosiana80@gmail.com

H. A. Zaenal Abidin
*Departement of Elementary School
 Teacher Education, Faculty of
 Education, Universitas Negeri
 Semarang, Semarang, Indonesia*
 Email: zaenrkt@mail.unnes.ac.id

Abstract—This research is based on the results of early observation in 3rd grade of primary school of Patemon 02, indicated in teaching materials only used theories without any practicum activity. The purpose of this research is to develop the design, to examine the feasibility, and to test the effectiveness of science teaching materials based on practicum in applies motion energy concept topic in primary school. This typical of research is Research and Development (R&D) with Borg and Gall model. The subject of this research is the 3rd grade students of primary school of Patemon 02. The sample of this research is purposive sample technique. Data analysis techniques uses descriptive statistic, normality analysis, t-test and N-gain. The result of the research shows that development science teaching material based practice in accordance with Borg and Gall procedure of research and development. Science teaching material based practice feasible to be used in science teaching with percentage of presentation content feasibility assessment of 84% from subject expert, presentation component feasibility assessment of 80%, and from practitioner with 100% of contend and component feasibility assessment. The result of t-test analysis is t-count 8,136 and more than t-table is 2,086, accordingly H_0 is received, its means learning-outcomes student results become different between before and after learning science by application of the concept of motion energy topic used science teaching material based on practicum. From the mean of learning-outcomes student results higher than before learning used science teaching material based on practicum. So it can be concluded that the science teaching material based on practicum can increase the mean of student learning outcomes in science learning, and is supported with N-gain test of pre-test and post-test reach to 0,45 by the medium criteria.

Keywords—*practicum, science, teaching materials*

I. INTRODUCTION

Sciences Education is an education in the field of study and all the processes that occur in it as an object. Through science education, students are expected to understand the process, products, values, and have a scientific attitude towards Natural Sciences, and can be responsive to environmental problems.

Learning Natural Sciences should be directly observed and applied in everyday life. Learning about science is not just memorizing formulas, but also the application of concepts to everyday life. The learning resources used are very limited, only referring to LKS

and BSE in the lack of other supporting books. In the learning process, students are never stimulated to do practicums or experiments on the excuse that the available teaching aids are very limited and still simple so the media is only used on certain materials. Whereas natural sciences places more emphasis on process skills and scientific attitudes, science should open opportunities to nurture students' natural curiosity.

For the sake of achieving science learning objectives in primary, then the delivery of material refers to one of the learning theories, namely Piaget's theory. Based on Piaget's learning theory, primary students are included in the concrete operational phase, which is between the ages of 7-11 years. At this stage, students are able using logic but still in the form of concrete objects, students have not can solve abstract problems. This means that children have logical operations that can be applied to concrete problems [13].

Natural Sciences learning in primary school should provide real experiences for students, also to avoid verbalism. In connection with this, it should be presented real objects or imitation objects so that students have the opportunity to touch, take action, see, and use it as a medium of observation or experiment so as to help students understand the concept.

Based on observations of researcher at primary school of Patemon 02 the learning process carried out by the teacher used lecture learning. This will make the memorization process or the transfer of knowledge from teacher to student without an optimal understanding. Besides that there is no other supporting book, so that only refers to LKS (worksheet) and BSE. From the results of interviews, researcher assume that students must be given an innovation in learning in order to be able to arouse enthusiasm in the learning process.

Learning by practicum has many benefits for the students. The positive impact of the application of the practicum method above encourages researcher to make improvements in the learning process by developing practicum-based science teaching materials to be able to assist students in understanding the material. According to the *National Center for Competency Based Training* [12], teaching materials are all forms of material used to assist teachers or instructors in carrying out the learning

process in the classroom. Practicum is one manifestation of scientific work in learning. Direct practice will facilitate the understanding of very complex abstract concepts. This makes it easier for students to understand complicated and abstract concepts along with concrete examples that are clear and related with the situations and conditions that are faced [18]. While the choice of science-based science teaching materials is based on the need for teaching materials that are still very minimal and less varied, by using practical science-based teaching materials students are expected to understand the concepts and material presented. Natural Sciences learning requires integrated contextual learning with practicum to instill concepts / content that are in line with scientific literacy skills. This is relevant to the research conducted by Sistiana Windyariani [19], et al., In 2016 entitled "Pengembangan Bahan Ajar Berbasis Konteks dan Kreativitas untuk Melatihkan Literasi Sains Siswa Sekolah Dasar". The results of other studies were conducted by Mbah Modesta Ifeoma [6] in 2013 with the title " *Use of Instructional Materials and Educational Performance of Students in Integrated Science (A Case Study of Unity Schools in Jalingo, Taraba State, Nigeria)*". The results showed that there were significant differences when students were taught using no teaching materials .

Teaching materials are prepared not only a set of facts, concepts, or principles that are all to be taken and remembered, but teaching materials must help students to construct knowledge and give meaning through real experience. According to Sagala (2013: 88) students need to be accustomed to solving problems, finding something useful for themselves, and struggling with ideas, namely students must construct knowledge in their own minds. Joni (in Harijanto, 2007: 2-4) also states that good teaching materials must specify learning experiences in the form of structuring learning activities that are rich in various variations, so that they can provide an accompanying effect that is as effective as achieving instructional goals.

Related to this, researcher use practical methods in the learning process. Nugroho [1] explains that learning with practicum is an important part that cannot be separated from teaching and learning activities. Practicum is the best media to develop science process skills because learning with practicum can provide opportunities for students to experience or do their own experiences that will be processed according to their cognitive abilities. Practicum-based learning is carried out with guided discovery methods that is by directly involving students in the learning process [17]. In line with the research conducted by Lilis Kurniawati [10], et al, in 2015 the results of her research showed that the application of learning with practical methods is suitable to be applied in the learning process and improve students' critical thinking skills so that their learning outcomes increase.

Based on the background of the above problems, the following problems can be formulated:

1. How do you develop practicum-based science teaching materials for the application of the third-class motion energy concept primary school of Patemon 02?
2. How is the worthiness of practicum-based science teaching materials for the application of the third-class motion energy concept primary school of Patemon 02?
3. How is the effectiveness of practicum-based science teaching materials for science learning outcomes on the application of the third-grade primary school of Patemon 02 motion energy concept?

II. METHOD

This study uses a research and development approach, with reasons according to the objectives to be achieved. Development research model developed by Borg and Gall [16]. According to Borg and Gall, " *educational and development (R & D) is a process used to develop and validate educational production* ". The research steps are carried out in a cyclical manner, and at every step taken refers to the results of the previous steps until finally a development product is obtained. The step are potentials and problems, data submission, product design, design validation, marking design, product test, usage test.

This type of data is qualitative data, to obtain expert validation data is carried out the dissemination of learning devices and research instruments by validators. Expert properness assessment data was obtained through a properness assessment sheet to be assessed and given input in the form of suggestions and criticisms. Practical science-based teaching materials are stated to be effective if students and teachers respond positively to learning activities by using science teaching materials for natural science learning.

The instrument used is an observation sheet from the activities of students doing practicum. The properness assessment sheet by the expert gets the value of the properness of the instrument and gets advice in the form of improvements to the *layout* and additional practicum on practicum-based science teaching materials. Questionnaire sheets are used for student and teacher responses to learning using natural science teaching materials for small-scale and large-scale tests. The *pretest* was given before *treatment* and *posttest* questions were given after *treatment*, namely learning by using science teaching materials. Data analysis technique used is descriptive qualitative analysis (learning device and instrument validation studies) and quantitative analysis (*t-test* and *gain*).

III. RESULT AND DISCUSSION

Development of Science Learning Materials Based on Practicum

Practicum-based Natural Science teaching materials for the application of third grade motion energy concepts were developed based on the questionnaire

analysis of the needs of students and teachers, from these results some things can be known: (1) the expected form of teaching material is rectangle with A5 paper size and thickness > 12 pages, (2) display of interesting teaching materials with colored *background* and illustrations that clarify the contents of the material, as well as practical instructions equipped with real drawings to clarify the steps of the activity, (3) the contents of the expected teaching material is the content of teaching materials with straightforward language, simple with varied sentences, making it easier for students to understand the material being studied.

Properness Results of Science-Based Learning Materials Based on Practicum

This study produced a product in the form of practicum-based science teaching materials for the application of motion energy concepts to the third grade of primary school of Patemon 02. The development of teaching materials through several stages including potential and problems, data collection through questionnaire needs of students and teachers, design of teaching materials, assessment of teaching materials, design revisions, product trials, and usage trials.

Practical science based teaching materials are teaching materials that are developed by involving the activeness of students in learning. This teaching material is equipped with practical activities that can facilitate students in understanding the concept, with an attractive design and accompanied by a real picture to clarify the material. It also aims to increase students' motivation and attractiveness towards the material being studied. In line with research conducted by Citraningrum [4], Merdeka Dina in 2016 which stated that to facilitate students to ease the students to memorize the material, it needs an interesting and applicable teaching materials and strategies as learning resources. This is also supported by research conducted by Sri Wahyuni [14] in 2015 entitled "Pengembangan Bahan Ajar IPA untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMP". The results of the study show that the teaching materials can increase students' motivation so students are interested in learning science. In addition to increase student learning motivation, teaching materials also have a positive impact on student learning outcomes. This is consistent with the research conducted by Matthew C. Nwike [11] in 2013 entitled " *Effects of Use of Instructional Materials on Students Cognitive Achievement in Agricultural Science* ".

The appraisal of the properness of science-based science teaching materials is done by using assessment instruments designed based on the Ministry of National Education (2008) and Kurniasih [9] and Sani (2014) which are modified.

Table 1. Recapitulation of Properness Assessment of Material and Media Components

| Evaluator | Component | Total score | Percentage | Criteria |
|--------------|-----------|-------------|------------|-------------|
| Validator | Material | 21 | 84% | Very decent |
| | Media | 20 | 80% | Worthy |
| Practitioner | Material | 25 | 100% | Very decent |
| | Media | 25 | 100% | Very decent |

Based on Table 1, it shows that practicum-based Natural Science teaching materials for the application of the concept of motion energy that has been developed, obtain a percentage of 84% included in the criteria of very decent by material experts, the percentage of 80% included in the criteria of media experts, and the percentage of experts 100% Practitioners fall into very decent criteria. In addition to providing a properness assessment, the three experts also provide suggestions for improving the science teaching materials. Improvements were made by researchers before small-scale trials.

Assessment of the properness of science teaching materials is also supported by the results of student and teacher response questionnaires in product trials with the acquisition of scores in a sequence of 92% and 100% in very decent criteria. So it can be concluded that the practicum-based science teaching material material is the application of the concept of motion energy worthy to be used in learning.

This is in line with the research conducted by Oni Arlitasari [2], et al, 2013, the title "Pengembangan Bahan Ajar IPA Terpadu Berbasis Salingtemas dengan Tema Biomassa Sumber Energi Alternatif Terbarukan" which shows that the products developed are feasible to use but there are few revisions to the components of content properness from material experts and the presentation of the components of properness from media experts. The value obtained from material experts, 165 in good criteria and 188 material experts in very good criteria. Relevant research was also carried out by Amrina Izzatika [7], et al, in 2015 the title "Pengembangan Bahan Ajar IPA Terintegrasi Pendidikan Karakter Tema Matahari Sebagai Sumber Energi". The results of the study showed that the validator's assessment of the science teaching material was very good and the limited test showed the students' responses were in good criteria.

Results of the Effectiveness of Science-Based Teaching Materials on Practicum

The effectiveness of practicum-based science teaching materials, one of which is known through the improvement of students' cognitive learning outcomes. Cognitive learning outcomes of students were obtained through *pretest* and *posttest* scores. *Pretest* value obtained before learning to use lab-based science teaching materials. While the *posttest* score was obtained

after learning using practical science-based teaching materials. After obtaining *pretest* and *posttest* scores, then the researchers tested the initial data of the product using the test formula Liliefors. Test Liliefors normality *pretest* value is 0.134 and *posttest* value is 0.178 with $\alpha = 0.05$ and L-table 0.183. Based on these data it was concluded that the *pretest* and *posttest* values $<$ L-table then H_0 is accepted so that both data are normally distributed.

After the initial data analysis, then the final data analysis uses a hypothesis test with a t-test of the difference in the average *pretest* and *posttest* test to determine the differences in *pretest* and *posttest* scores. From the data above obtained an average *pretest* score of 56 and an average *posttest* score of 76, there is an increase in learning outcomes by 20. In addition the number of students who experienced completeness also experienced an increase of 4 students with a percentage of 18% to 16 students with a percentage 73% at *posttest*. The results of differences in the average *pretest* and *posttest* values are presented in table 2.

Table 2. T-test Data Value *pretest* and *posttest*

| Data | (α) | D | | Information |
|-----------------|--------------|---|-------|-------------|
| <i>Pretest</i> | 5 | 2 | 2,080 | 8,13680802 |
| <i>Posttest</i> | % | 1 | | 7 |
| | | | | accepted |

Based on table 2, it is obtained t_{count} 8,136 and t_{table} obtained from the calculation and then confirmed in the t distribution value table which is 2.080. T-count greater than t-table then H_a is accepted. So it was concluded that practicum-based natural science teaching materials were effectively used in science learning material on the application of class III motion energy concepts, because there were differences in the average *pretest* and *posttest* scores.

The next step is to calculate *N-gain*. From processing the data, the results are obtained in table 3.

Table 3. Average Improvement Test (*Gain*)

| Category | Value |
|--------------------------------|-------------|
| Gain value | 0,465137202 |
| Average <i>pretest</i> | 55,54545455 |
| <i>Posttest</i> average | 76,22727273 |
| Criteria | Medium |

Based on Table 3 is known that the average *pretest* score 56 and the average score of *posttest* 76. Average increase (*gain*) of data *pretest* and *posttest* 0,46 included in the criteria being the average difference of 20. This is consistent with research previously carried out by Khoiriah [8], Tri Jalmo, Abdurrahman, in 2016 entitled "*The Effect of Multimedia-Based Teaching Materials in Science Toward Students' Cognitive*

Improvement". The results showed that multimedia-based teaching materials in science learning had a significant effect on student cognitive learning outcomes as shown by an average of 0.78.

Use of science-based science teaching materials material the application of the concept of energy of motion is a new learning source obtained by students. Students look enthusiastic about the learning resources. Students follow the learning steps in the instructional materials well and according to instructions, so that students can learn independently.

In addition to the results of *pretest* and *posttest* learning, the effectiveness of teaching materials in this study was supported based on student and teacher response questionnaires after participating in learning using practicum-based science teaching materials conducted on large-scale trials. There are 4 assessment criteria, including very decent 80% -100%, feasible with a range of 60% -80%, quite feasible with a range of 40% -60%, and less feasible with a range of 20% -40%.

Based on these data it can be concluded that the students' responses to the use of practicum-based science teaching materials received a positive response, it is stated that the teaching materials included in the criteria are very effective for use in science learning. Practicum-based Natural Science teaching materials are said to be very effective with the results of the questionnaire responses of students getting an average score of 20.4 with a percentage of 92.7% included in the criteria very effective. With the lowest percentage result of 77% in the message aspect of the sentence and the highest percentage of 100% in the usefulness aspect of teaching material in this case the students claimed to be happy because the practicum-based science teaching materials can facilitate students in learning, the activities are fun because there are lots of practicum so students experience it directly, equipped with instructions for using practicum and the problems are easy to understand. The results of the questionnaire responses of the third grade teachers of primary school of Patemon 02 showed a very positive response after learning using practicum-based science teaching materials. This is indicated by the acquisition of 100% percentage in all aspects.

From the results of the study concluded that practicum-based science teaching materials are effective to improve student learning outcomes in science learning material application of the concept of motion energy. Recapitulation of the results of process skills assessment, namely practical activities are presented in table 4.

Table 4. Recapitulation of Process Skills Assessment Results

| No. | Practice | Average Score | Criteria |
|-----|----------------------------|---------------|-----------|
| 1. | Windmill | 85 | Good |
| 2. | The plane flies from paper | 93.5 | Very good |
| 3. | Rockets | 85 | Good |
| 4 | Simple steamship | 86 | Good |

| | | | |
|----------------|--------------|------|------|
| 5. | Spiral paper | 85 | Good |
| 6. | Water wheel | 90 | Good |
| Average | | 87.4 | Good |

Based on Table 4 shows that cognitive learning outcomes are supported by student process skills while doing practical activities. Because the fact is that by doing practical work, not only psychomotor students will get better, but practicum activities to support students' cognitive with the score are in good criteria. Material preparation covers all components of the Natural Sciences, and emphasizes more on process skills and scientific attitudes. In accordance with the opinion of Cain [3] and Evan (1990) natural sciences as a process that is understanding how to obtain natural sciences products. So that the instructional materials are prepared through the scientific method, that is, with a variety of practical practicum activities that are able to improve students' understanding so that learning is more meaningful. In addition, it is also supported by learning theories, among others, Piaget's cognitive development theory, constructivism theory, Vygotsky's theory, and cooperative learning theory. Where these theories explain that primary school children are still in the concrete operational phase so that they need media to visualize abstract objects, and learning must involve the active role of students to try themselves so that learning is more meaningful.

These results are in line with the research conducted by Yuni, et al., In 2013 the title "Application of Product-Based Biology Practicum Module to Improve Students' Science Process Skills (KPS) in Class X of Lemahabang 1 State High School, Cirebon" . Based on the results of the study it can be concluded that the application of the biological practicum module can improve science process skills, so that the cognitive learning outcomes of students can be supported through practicum.

Development of practicum-based science teaching materials has advantages, including: (1) instructional materials make students believe more in the truth or conclusions based on their own experiments rather than just receiving information from teachers or books, (2) teaching materials present presents practical methods that emphasize students so that it is more active in the learning process, (3) this teaching material has differences with other books, including teaching materials designed according to student characteristics, involving the active role of students in discovering concepts through several practicums and observations, there are guidelines for using books, this teaching material is accompanied by group and independent tasks so as to increase student activity, there is a final evaluation, enrichment and improvement, and is equipped with a process skills assessment rubric in each practical activity.

IV. CONCLUSION

Based on the discussion and data analysis in the study can be summarized as follows: (1) practicum-based science teaching materials for the application of motion energy concepts to the third grade were developed based on the questionnaire analysis of the needs of students and teachers on science teaching materials covering aspects of appearance, content, and language; (2) based on the assessment of material, media, and practitioner experts and supported by the responses of students and teachers in product trials stated that practicum-based science teaching materials are very suitable to be used in science learning material application of the concept of motion energy; (3) practical practicum-based natural science teaching materials are used to improve student learning outcomes with an average increase of 0.46 included in the medium criteria.

REFERENCES

- [1] Arifin, Uma Fadzilia, dkk. 2015. "Pengembangan Lembar Kerja Praktikum Siswa Terintegrasi Guided Inquiry untuk Ketrampilan Proses Sains". *Chemistry in Education*, 4 (1): 54-60.
- [2] Arlitasari, Oni, dkk. 2013. "Pengembangan Bahan Ajar IPA Terpadu Bebas Salingtemas dengan Tema Biomassa Sumber Energi Alternatif Terbarukan". *Jurnal Pendidikan Fisika*, 1 (1): 81.
- [3] Cain, Sandra E., dan Evans Jack, M. 1993. *Sciencing: An Involvement Approach to Primary Science Methods*. Columbus: Meril Publishin Company.
- [4] Citraningrum, Dina Merdeka. 2016. "Pengembangan Bahan Ajar Menyenak-Berbicara untuk Siswa SMP Dengan Pendekatan Kontekstual". _____, 1 (2): 130-139.
- [5] Depdiknas. 2008. *Panduan Pengembangan Bahan Ajar*. Depdiknas.
- [6] Ifeoma, Mbah Modesta. 2013. "Use of Instructional Materials and Educational Performance of Students in Integrated Science (A Case Study of Unity Schools in Jalingo, Taraba state, Nigeria)". *Journal of Research & Method in Education*, 3(1): 7-11.
- [7] Izzatika, Amrina, dkk. 2015. "Pengembangan Bahan Ajar IPA Terintegrasi Pendidikan Karakter Tema Matahari Sebagai Sumber Energi". *Journal of Primary Education*, 4 (1): 24-29.
- [8] Khoiriah, dkk. 2016. "The Effect Of Multimedia-Based Teaching Materials In Science Toward Students' Cognitive Improvement". *Jurnal Pendidikan IPA Indonesia (JPPI)*, 5 (1): 75-82.
- [9] Kurniasih, Imas. 2014. *Panduan Membuat Bahan Ajar Buku Teks Pelajaran Sesuai dengan Kurikulum 2013*. Surabaya: Kata Pena.
- [10] Kurniawati, Lilis Akbar, dkk. 2015. "Pengaruh Penerapan Metode Pembelajaran Praktikum Terhadap Keterampilan Berpikir Kritis Matematika Siswa Kelas VIII SMP N 3 Sumber Kabupaten Cirebon". *Jurnal EduMa*, 4 (2): 62-74.

- [11] Nwike, Matthew C. 2013. “*Effects of Use of Instructional Materials on Students Cognitive Achievement in Agricultural Science*”. *Journal of Educational and Social Research*, 3 (5): 103-107.
- [12] Prastowo, Andi. 2015. *Panduan Kreatif Membuat Bahan Ajar Inovatif*. Yogyakarta: Diva Press.
- [13] Rifa’i, Achmad, dkk. 2012. *Psikologi Pendidikan*. Semarang: UNNES PRESS.
- [14] Sri, Wahyuni. 2015. “Pengembangan Bahan Ajar IPA Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMP”. *Jurnal Materi dan Pembelajaran Fisika (JMPF)*, 5 (2): 300-305.
- [15] Sufinah, Siti Yuni, dkk. 2013. “Penerapan Modul Praktikum Biologi Berbasis Produk Untuk Meningkatkan Keterampilan Proses Sains (KPS) Siswa Di Kelas X SMA Negeri 1 Lemahabang Kab Cirebon”. *Jurnal Scientiae Educatia*, 2 (2).
- [16] Sugiyono. 2015. *Metode Penelitian Pendidikan*. Bandung: Alfabeta.
- [17] Suparno, P. 2007. *Metode Pembelajaran Fisika*. Yogyakarta: Universitas Sanata Dharma.
- [18] Uno, Hamzah B. dan Nurdin Mohamad. 2011. *Belajar dengan Pendekatan PAILKEM*. Jakarta: PT. Bumi Aksara.
- [19] Windyariani, Sistiana, dkk. 2016. “Pengembangan Bahan Ajar Berbasis Konteks dan Kreativitas Untuk Melatihkan Literasi Sains Siswa Sekolah Dasar”. *Jurnal Bioedukatika*, 4 (2): 9-15.