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THE INFLUENCE OF PRACTICUM-BASED OUTDOOR INQUIRY MODEL ON SCIENCE PROCESS SKILLS IN LEARNING PHYSICS

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Abstract: *The main purpose of this study is to find out the influence of practicum-based outdoor inquiry model on science process skills. Quasi-experiment design was employed as the research method by Matching Only Post-test Control Group. The research sample was taken using a cluster sampling technique. The samples consisted of experimental class (XI MIA 1) in a total of 25 students treated with practicum-based outdoor inquiry model. The control class (XI MIA 3) consisted of 29 students treated with direct instruction model. In collecting the data, essay test was used in the form of worksheets containing the aspect of science process skills of formulating hypotheses, designing experiment, interpreting data into tables, and drawing a conclusion (inferring). The study results demonstrate that practicum-based outdoor inquiry model was effective in improving the science process skills. It was shown in p-value (significant) of 0.00. The implication of this study is the need to design a practicum-based outdoor inquiry model by noticing what skills are going to improve by means of more varied outdoor activities.*

Keywords: *learning physics, practicum-based outdoor inquiry, science process skills*

INTRODUCTION

Outdoor learning model can be one of the ways to induce a sense of care toward surroundings and generate a sense of curiosity that will be the link to the reality-based solution discovery based in solving problems (Ampuero, Miranda, Delgado, Goyen, & Weaver, 2015). Problems that are found and dealt with in real life can be such a learning material in conducting direct field investigation (Maulidiyahwarti, Sumarmi, & Amirudin, 2016). Outdoor learning is able to explore teachers' and students' abilities in scientific investigation efforts by utilizing the unlimited technology in the form of their environment (Kali, Levy, Levin-peled, & Tal, 2018).

The process of outdoor learning can generate the opportunity to develop a student's critical thinking (Christie, Beames, & Higgins, 2016). Outdoor learning application is able to develop science process skills and problem-solving ability (Wahyuni, Indrawati, Sudarti, & Suana, 2017).

Problem-solving through inquiry will lead the participants to the sense of curiosity and student's high thinking ability in finding information (Maulidiyahwarti, Sumarmi, & Amirudin, 2016). A sense of curiosity is not simply in forms of facts, concepts, and principles, but also including formal and informal processes in the discovery which are able in generating practicum activities (Wu, Jen, Kuo, Hsu, & Wu, 2018). Physics learning through practicum activities with the help from discovery-based practicum guidelines is able in developing students' thinking skills (Sulistiyono, Mundilarto, & Kuswanto, 2017).

Learning physics can be done by using direct instruction model that is oriented in syntax, presentations, and phases of structured exercise and independent exercises (Kanfush, 2014). Direct instruction model is a learning model that emphasizes gradual mastery of the concept and learning materials. Some weaknesses of direct instructions are, among others, (1) depending on teacher's ability as a central role, (2) only emphasizing on listening, observing, and taking note for student's skills, (3) not involving much student's role thus only a little portion of material delivered can be remembered or memorized, and (4) evoking student's sense of boredom (Prastowo, 2013).

Learning physics through guided inquiry learning model has a positive influence on improving science process skills and the results of learning physics itself (Iswatun, Mosik, & Subali, 2017). Learning physics with the motivation of finding the facts is determined by the presence of four behavioral aspects, i.e. attention, relevance, self-confidence, and satisfaction (Sari, Sunarno, & Sarwanto, 2018). Student's motivation will increase by connecting the concepts of physics with their real lives and their surrounding environment (Holubova, 2015).

Learning processes will be interesting, enthusiastic, and will familiarize the students with to work scientifically through the learning process of finding facts (inquiry) from their surrounding environment (outdoor) (Hakim, Suparmi, & Masykuri, 2017). Also, outdoor learning can be applied in sustainable ways into the school curriculum as one of the challenges for the teacher's exploration (Remington & Legge, 2016). Fact-finding process (inquiry) supports student's mastery of concepts that will lead to a positive result in student's better achievement (Mupira & Ramnarain, 2018).

Improved process skills can be achieved and trained by means of practicum-based learning (Hidayah, Arifuddin, & Mahardika, 2017). Through practicum activities, students are given with bigger opportunity to explore science process skills like formulating and testing hypotheses (Liandari, Siahaan, Kaniawati, & Isnaini, 2017). The result of science process skills can be measured by using a test instrument on science process skills (Noor & Wilujeng, 2015). Process skill performances, i.e., skills to observe, predict, conduct experiment, measure, and communicate, are measured by using an instrument of observation assessment sheet (Supahar, Rosana, Ramadani, & Kurnia Dewi, 2017).

Three basic science process skills are observing, measuring, and using practicum equipment (Juhji, 2016). Whereas, four skills are predicting the data (hypothesizing), interpreting the data, communicating, and inferring the data. One of study result stated that the skills of predicting, interpreting, communicating, and inferring the data were still considered low thereby students still face difficulty for performing higher thinking in solving problems (Juhji, 2016).

The problem of low science process skills can be solved by using inquiry learning model (Iswatun et al., 2017). Students are able to transfer better the information they gathered and to better explore information independently and extensively through this inquiry learning (Sheftyawan, Prihandono, & Lesmono, 2018). Improving student's science process skills can be achieved by applying the combination of guided inquiry model of learning and STAD (Erina & Kuswanto, 2015).

Improved science process skills can be obtained by implementing the inquiry model in combination with physics practicum on the subject of real-virtual images (Puji Hartini, 2017). By means of experiment method with the guided inquiry, student's process skills of observing, conducting an experiment, communicating, predicting and inferring increased significantly (Subekti & Ariswan, 2016).

One of the subject matters in Physics that has led to misconception is the concept of optics (Suwarna, 2013; Agnes, Kaniawati, & Danawan, 2015). Identification showed that the highest misconception is about magnifying glass, while the lowest one is about microscope and telescope (Munawaroh & Setyarsih, 2016). In addition, students still have a misconception about image formation and image properties on positive lenses (Sheftyawan, Prihandono, & Lesmono, 2018). Therefore, from the problem identification result, it requires a follow up so that process skills and student's learning result can be improved, especially about the optics subject matter in the sub-chapter of a magnifying glass.

The observation result on the learning process in State Senior High School 1 Sleman (SMA N 1 Sleman) revealed that teachers used direct instruction model with laboratory practicum method. Most of the students got world-weary as the practicum was conducted only in the laboratory. Moreover, the laboratory facilities were still less optimal in supporting the learning process. The constraint of laboratory facilities became the main problem that hindered process skill improvement. Therefore, it requires a strategy for not only conducting practicum in the laboratory. SMA N 1 Sleman has a landscape that is highly supportive of outdoor learning activities. This school has a big yard, some gazebos, and some parks surround them which are located close to classes. The teachers apply outdoor inquiry as one way of making students more active during the learning process to improve their process skills.

The purpose of this study was to find out the application of outdoor inquiry model combined with practicum activities on improving science process skills. Aspects of process skills being improved in this study were formulating hypotheses, designing outside-the-class experiment (outdoor activities), interpreting data into tables, and drawing a conclusion (inferring).

METHOD

As a quantitative study, it employed a research method of quasi-experiment by using the matching only posttest control group. It was conducted in SMA N 1 Sleman in the school year of 2017/2018. Cluster sampling was chosen as sample taking technique.

Research subjects consisted of two classes, i.e. Class XI MIA 1 as experiment class and XI MIA 3 as control class. The numbers of research subjects for the experiment class were 25 students, whereas the control class was 29 students.

Variables of science process skills were assessed based on student’s answers on Student Worksheet (SW). These student worksheets contained the subject matter of magnifying glass. The student worked on the SW individually, even though the practicum was done collectively. Before given for field testing, SW had been validated by experts in this subject. It resulted in an assessment data that the SW instrument on magnifying glass subject matter had been used without revision with score details for content aspect was categorized very good (score 4), and language aspect was very good (score 5). Table 1 presents the design of *the matching only posttest control group*.

Table 1. *The Matching Only Posttest Control Group*

Class	Matching	Treatment	Posttest
Experiment	M	X	O
Control	M	K	O

Description :
X = practicum-based outdoor inquiry model
K = direct instruction model
O = science process skills

Research variables comprised of independent and dependent variables. Practicum-based outdoor inquiry model and direct instruction model constituted the independent variables. Meanwhile, science process skills were the dependent variables.

The following Table 2 outlines the assessment rubric for science process skill aspect.

Table 2. Assessment Rubric for Science Process Skill (SPS) Aspects (Maradona, 2013)

No	SPS	SPS Indicators	Score
1	Formulating hypotheses	1. Formulating rational hypotheses 2. Hypotheses that use concepts, theories, and laws 3. Hypotheses are in accordance with the purpose of the experiment 4. Using good and correct language, as well as logical	Score 4 if 4 indicators are met Score 3 if 3 indicators are met Score 2 if 2 indicators are met Score 1 if 1 indicator is met Score 0 if 0 indicators are met
2	Designing an experiment	1. The student is able to find suitable equipment and materials with the experiment 2. Students are able to design an experiment 3. Able to make systematical and coherent experiment procedures 4. Using good and correct language	Score 4 if 4 indicators are met Score 3 if 3 indicators are met Score 2 if 2 indicators are met Score 1 if 1 indicator is met Score 0 if 0 indicators are met
3	Interpreting the data	1. Combining all information from various theories with the experiment results 2. Connecting between variables 3. Discovering the pattern of observation results 4. Putting the experiment data into suitable tables	Score 4 if 4 indicators are met Score 3 if 3 indicators are met Score 2 if 2 indicators are met Score 1 if 1 indicator is met Score 0 if 0 indicators are met
4	Inferring (drawing conclusion)	1. Conclusions are in accordance with the experiment results 2. Linking tendency between variables 3. Related to experiment hypotheses 4. Using language inappropriate with physics concepts	Score 4 if 4 indicators are met Score 3 if 3 indicators are met Score 2 if 2 indicators are met Score 1 if 1 indicator is met Score 0 if 0 indicators are met

Data collection was carried out by using an essay test in Student Worksheet (SW). The essay test and observation sheet contained assessment rubric for science process skill indicators being studied. Data was gathered when the practicum process was taking place. Students conducted practicum activity on Magnifying glass subject matter through some activities steps in accordance with inquiry outdoor model syntax. Table 3 presents outdoor inquiry model syntax as follow.

Table 3. Outdoor Inquiry Model Syntax

Science Process Skills	Outdoor Inquiry Phases				
	1	2	3	4	5
Formulating Hypotheses	v	v			
Designing an experiment			v	v	
Integrating data into tables				v	
Inferring conclusion					v

Description:
Phase 1: Problem orientation
Phase 2: Hypotheses formulation
Phase 3: Data collection
Phase 4: Hypotheses testing
Phase 5: Data analysis

The next step was that students completed the essay test in their Student Worksheet (SW) that contained problems or items had been adjusted to science process skills being assessed. The following Table 4 shows the reference scale for SW assessment (Widoyoko, 2014)

Table 4. Four Criteria Scale of Assesment

The range of average score	Category
X>3,25	Very Good
2,50<X≤ 3,25	Good
1,75<X≤ 2,50	Sufficient
1,00 <X ≤ 1,75	Not Good

(Widoyoko, 2014)

Score achievement results for science process skills, both for control class and experiment class, were tested by means of Independent Sample t-Test and One-

Sample t-Test by employing SPSS 17.0. Independent Sample t-Test means that significant value of <0,05 can be concluded that H_0 is rejected and H_1 is accepted. It indicates that there is a difference in science process skill results between experiment class and control class. Meanwhile, the learning model is said as effective when p-value (significance) is < 0.05 in One-Sample t-Test.

RESULTS AND DISCUSSION

According to the experts of learning instrument, validation result for Student Worksheet on Magnifying glass subject matter that can be presented is content and language aspects. The score for content aspect is 4 and score for language aspect is 5. All aspects are categorized as very good. Table 5 is the results of science process skills for those two classes (control class and experiment class).

Table 5. Results of Science Process Skills

Aspects of Science Process Skills	Control Class	Experiment Class
Formulating hypotheses	2,27	3,32
Designing an experiment	2,23	3,20
Interpreting data into a table	2,27	3,40
Inferring conclusion	2,60	3,36

The following is a further detailed explanation for the results of science process skills in Table 5 presented above.

Science Process Skills

1. Formulating Hypotheses

   From Table 5, it can be seen that the result of science process skill of formulating hypotheses for control class was 2.27 (categorized as sufficient), whereas for experiment class was 3.32 (very good). Both of these results demonstrate that practicum-based outdoor inquiry learning model was more effective compared with the conventional model in drilling student's skill in formulating hypotheses. In this case, students in the experiment class had the aspect of science process skill in formulating hypotheses. The students were able to predict what phenomenon was going to happen based on the problem given in problem orientation. The following is Figure 1 that comprises the student's answer sheet in experiment class in formulating hypotheses

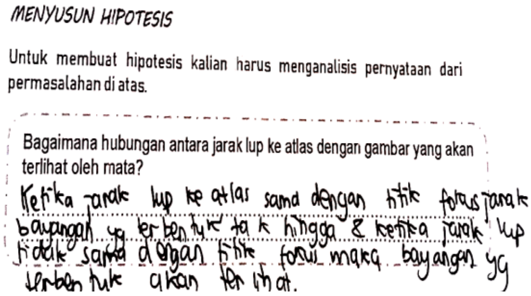

Figure 1. Student's answer sheet in formulating hypotheses

2. Designing an experiment

   It shows in Table 5 that the ability to design an experiment for control class was 2.23 (categorized as sufficient), while for experiment class was 3.20 (good). This indicates that students in the experiment class, after joining the practicum-based outdoor inquiry learning model, employed the experiment in a logical way in accordance with the concepts in physics. They were also able to identify control variables and dependent variables in accord with the experiment they were designing. The following Figure 2 shows student's answer sheet in experiment class in designing experiment.

Lakukan eksperimen dengan jujur, tekun dan penuh tanggung jawab untuk menganalisis bayangan yang terbentuk pada lup.

Di bawah ini tersedia alat dan bahan percobaan berupa :

1. Lup
2. Kertas bertuliskan huruf kecil
3. Mistar 100 cm

Tulis langkah kerja yang dilakukan pada kolom dibawah ini.

Langkah kerja:
1. siapkan alat & bahan
2. letakkan benda yg akan diamati pd bidang datar
3. letakkan lup di jarak yg diinginkan
4. Hitung jarak lup & benda yg diamati
5. amati benda melalui lup untuk mendapatkan bayangan yg jls
6. Hitung jarak antar lup & mata
7. Catatlah hasil pd tabel
8. ulangi cara ke-4 - 7 dg jarak yang berbeda antara lup & jarak yg diamati

Figure 2. Student's answer sheet in designing an experiment

3. Interpreting data into a table
   As shown in Table 5, the aspect of interpreting data into a table for control class was 2.27 (categorized as good), while for experiment class was 3.40 (categorized as very good). This exhibits that students in the experiment class, after conducting an experiment based on their experiment design, were able to integrate the numbers of experiment results into tables in the appropriate measured quantity. Figure 3 below is the student's answer sheet in interpreting data into the table.

Syarat mata tidak berakomodasi

$(s = f)$

Syarat mata berakomodasi maksimum

$s' = s_n$

Lakukanlah percobaan di atas dengan menggunakan alat-alat yang telah disediakan dan catatlah data yang diperoleh dalam tabel!

Data Hasil Pengamatan

No	Jarak benda terhadap lup (cm)	Jarak lup terhadap mata (cm)	Jarak fokus (cm)	Mata berakomodasi /mata tidak berakomodasi
1	10 cm	20 cm	6,67 cm	Berakomodasi
2	11 cm	28 cm	7,9 cm	Berakomodasi
3	8 cm	17 cm	5,44 cm	Tidak berakomodasi
4	9 cm	41 cm	7,38 cm	Tidak berakomodasi

Figure. 3. Student's Answer Sheet in Interpreting Data into Table

4. Inferring conclusion
   Table 5 shows the result of inferring skill for control class was 2.6 (categorized as good), whereas for experiment class was 3.36 (categorized as very good). It reveals that students who experienced a practicum-based outdoor inquiry learning process were able to create ideas from observation. They had been trained in inferring ideas from object condition based on concepts in Physics. The following Figure 4 presents the student's answer sheet in drawing a conclusion (inferring).

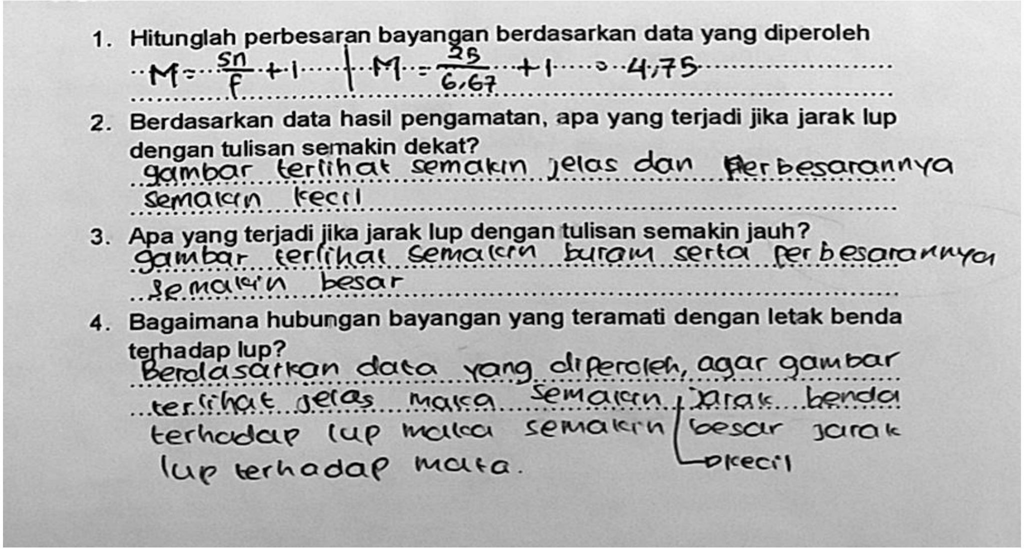

Figure. 4. Student's Answer Sheet in Drawing Conclusion (Inferring)

As to t-test result for science process skill score, SPSS17.0 was employed. Table 6 presents the t-test results for Science Process Skills (SPS) by using SPSS 17.0.

Table 6. T-test for Science Process Skills

	t	Sig (2-tailed)	Std. Differences Error
SPS	10.646	.000	1.945
	10.781	.000	1.920

T-test results for Science Process Skills score by using SPSS 17.0.

H_0 = there is no difference in science process skill results between experiment class and control class

H_1 = there is a difference in science process skill results between experiment class and control class

As presented in Table 6, significance value (2-tailed) = 0.000. This result interprets the significance value of <0.05. Therefore, it can be inferred that H_0 is rejected and H_1 is accepted. This means that there is a difference in science process skill results between experiment class and control class. It also can be seen from the T-test result that significance value (2-tailed) for experiment class was 0.000 which means that practicum-based inquiry model for learning was effectively applied in this experiment class.

Each converted value was further tested with One Sample t-Test as shown in Table 7 in order to discover the effectiveness of the learning model in those two classes. This table was the result of one sample t-Test for Control Class and Experiment Class.

Table 7. One Sample t-Test in the Control Class and Experiment Class

Category	Control Class	Experiment Class
Sig. (2-tailed)	.835	.000

Based on the analysis results of Independent Sample t-Test by means of SPSS 17.0, Table 7 shows that significance level (2-tailed) = 0,000. These results interpret the significance of < 0.05. The t-Test results in this table demonstrate that science process skills for students in experiment class was sig (2-*tailed*) of 0.000, means that practicum-based inquiry model for learning was effectively applied in this experiment class.

Means score of science process skills for experiment class was 3.32 (categorized as very good), whereas the means score of science process skills for the control class was 2.47 (or categorized as sufficient). These results are in line with the other studies stating that science process skills were increasing after applying inquiry model (Rahmasiwi, Santosari, & Sari, 2015) and learning through experiment method (Ratunguri, 2016).

Aspects of science process skills like formulating hypotheses, interpreting data, and inferring conclusion were categorized as good, with skill in designing experiment was categorized as very good. The enhancement of those aspects of science process skills was supported by study results asserting that practicum-based inquiry model for learning was more effective in improving science process skills, more particularly for aspects of designing an experiment and formulating hypotheses (I. Risnawati, I. Kaniawati, 2013)

CONCLUSION

Practicum-based inquiry model for learning is effective in improving science process skills in learning Physics. It is indicated from a *p-value* of science process skills for experiment class was < 0.05, i.e. 0.000.

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