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Research Article

Teaching science process skill using guided inquiry model with starter experiment approach: An experimental study

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ABSTRACT

Numerous challenges occur in education field require effective solutions to encounter. The aim of this research was to investigate the effectiveness of guided inquiry model with starter experiment approach in teaching science process skill. This quasi-experimental research employed non-equivalent control group design. A total of 64 students of X MIPA$_1$ and X MIPA$_5$ was selected as the sample. In selecting the sample, the researchers applied cluster random sampling while the data was collected by using test. The data was analyzed using ANCOVA after underwent prerequisite normality and homogeneity tests (α = 0.05). The results showed that the mean of posttest was 79.33%. The improvement of science process skill was 44.88%, compared to the pretest results. The results of ANCOVA revealed that the significance value was of 0.025. This means that the guided inquiry model with starter experiment approach in teaching science process skill of the students is effective.

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INTRODUCTION

The success of the learning process is mostly determined by several fundamental aspects of the classroom (Duran, Işik, Mihladiz, & Özdemir, 2011). Some of the components indicated have an impact on the success of learning, among others, the teachers' ability in the model, method, and learning approach (Leow & Neo, 2014; Lieberman, 2009). However, teachers often ignore the importance of these aspects. Learning that is done with proper planning, such as using models and methods that are following the characteristics of the material delivered can have a positive impact on students (Scott, 2015; Tayeb, 2017). Some of the effects reported arising from the good practice of learning planning are the growth of students' science process skills (Ergul et al., 2011; Serevina, Sunaryo, Raihanati, Astra, & Sari, 2018). Especially for learning science such as biology, involving students directly through learning experiences is very meaningful for science process skills (Guleker, 2015; Subali, 2010).

Based on the observations in SSHS 1 of Kasihan, the biology learning process adopts the 5E learning model. However, teachers often use the lecture method to anticipate time constraints, and the number of concepts students must understand. Furthermore, material about fungi is one material that has not been taught optimally. Besides that, learning activities based on laboratory investigations are limited, only done twice to three times in one semester. These problems have implications for the involvement of students in the learning process, which is relatively low, this has an impact on learning outcomes that are also classified as low with a success rate of 40%. The average score of students under 70 is the minimum indicator of success. One of the solution to fix the problems is make students more active in learning and stimulating their science process skills (Mutammimah, Jumadi, Wilujeng, & Kuswanto, 2019; Ongowo & Indoshi, 2013).

However, several studies report that students' science process skills are empowered (Purwati, Prayitno, & Sari, 2016; Ranya, Jamhari, & Rede, 2013). Student involvement in learning activities is still often limited to limited discussion and listening to teacher explanations (Noviana & Rahman, 2013; Tamsyani, 2016). The learning model carried out is often not able to engage students actively physically or involve direct experience. Low learning involvement has implications for students' relatively low science process skills (Rahmasiwi, Santosari, & Sari, 2015). In general, students have difficulty mastering science process skills (Ugulu, 2009). Whereas, this skill is one of the fundamental aspects needed by 21st Century students.

Low science process skills are caused by several factors, such as limitations of laboratory resources including human resources and supporting infrastructure (Jack, 2013), textbook-based learning (Chatila & Husseiny, 2017; Ekene & Oluoch-Suleh, 2015), and material mismatches with the models and methods used (Sukarno, Permanasari, & Hamidah, 2013). The last-mentioned factor is very closely related to how the teacher competencies. Dynamically, teachers need to practice designing learning that involves students actively (Reiser, 2001; Vlassi & Karaliota, 2013). One model that is reported to improve science process skills is direct experience involving some applications of real subjects and direct activities through practical work (Mutammimah et al., 2019).

Abungu, Okere, and Wachanga (2014) explain that learning involving direct experience can help students understand the material for the long term. The development of science process skills is needed to improve the process of thinking and inquiry skills as the basis for inquiry learning (Jack, 2013). One learning model that activates thinking and inquiry skills is the inquiry learning model. In other words, science process skills can be developed through the implementation of learning based on the process of discovery through investigations such as inquiry learning (Ongowo & Indoshi, 2013).

One of the learning approaches reported following inquiry is a starter experiment approach (Syla & Hodolli, 2017). This approach focuses on philosophical concepts and didactic learning methods. Learning objectives and orientations primarily emphasize knowledge, repetition and reconstruction, application, understanding, observations from various perspectives, and thought formation (Aflalo & Gabay, 2013). However, research that examines the starter experiment approach and the development of science process skills is still limited. The research of the starter experiment approach in the last 10 years is limited to improving biology and science learning outcomes (Dibia & Adiasih, 2017; Jaya, 2014; Saputra, Tegeh, & Widiana, 2017) both at the elementary (Indriarini & Bayu, 2019; Nyeneng, Lasmawan, & Dantes, 2015), middle (Lapangandong, Ali, & Kade, 2016) and high school levels (Andini, Hidayat, Fadillah, & Permana, 2018; Suwama, 2012).

On the other hand, the study of the implementation of the inquiry learning model was reported to have a significant impact on improving student process skills (Duran et al., 2011; Ergul et al., 2011). The application of inquiry in learning as well as in combination with cooperative learning models is indicated to be able to maximize students' thinking abilities and science process skills (Gumilar, Wardani, & Lisdiana, 2019; Pedaste et al., 2015; Wijayaningputri, Widodo, & Munasir, 2018). Many studies say that the learning model is very appropriate when implemented in material that requires investigation such as phenomena related to physiological processes to the diversity of living things (Jalil, Ali, & Haris, 2018; Musawi, Asan, Abdelraheem, & Osman, 2012; Rahmawati, Alimah, & Utami, 2017). This research aims to develop the students' science process skill by implementing guided inquiry model with starter experiment approach in the level of senior high school.

METHOD

This study was quasi-experimental with a non-equivalent control group design (Table 1). Table 1 shows that the first step to do is determining the sample for both experimental class and control class. The study was conducted using pretest and posttest in both the control class and the experimental class. Guided inquiry was applied in the experimental class, whereas 5E model was applied in the control class. The success of the treatment was determined by comparing the result of pretest and posttest.

Table 1. Non-equivalent control group design

Group	Pretest	Treatment	Posttest
Experiment	G_1	S_x	G_2
Control	G_3	S_0	G_4

This research was carried out in the State Senior High School (SSHS) 1 of Kasihan, Bantul, Special Region of Yogyakarta. This research was conducted during November 2018 in accordance with the semester learning program at the school that took material about fungi. The subject of this study involved 64 students of X-MIPA$_1$ (experimental class) and X-MIPA$_5$ (control class). Determination of the subject using cluster random sampling.

The data were collected by using tests. These instrument consists of seven essay test items to measure students' science process skills. The validity of the instrument consists of content validity and construct validity. The validity of instrument items was analyzed using Pearson correlation, while the reliability of instrument items was analyzed using Alpha-Cronbach. Based on the reliability test values obtained are 0.773 > 0.444. Therefore, all test items are reliable and consistent.

The prerequisite test was carried out to determine the normality and homogeneity of the data. The normality test uses Kolmogorov-smirnov with a significance level of α (0.05), while the homogeneity test uses the Levene test with a significance level of α (0.05). Science process skill data were tested using analysis of covariance (ANCOVA).

RESULTS AND DISCUSSION

The results of the average score of the pretest and posttest in the experimental class and the control class are shown in Table 2. The data illustrates students' science process skills. As shown in Table 2, the students' mean score were increased. The students' mean score of pretest in the control class was 30.17, while the score of posttest was 70.16. In the experimental class, the students' mean score of pretest was 34.45, whereas the posttest score was 79.13. These results indicated that the students' science process skill in the control class increased by 39.99%, smaller than the experimental class whose increase reached 44.88%. Figure 1 depicts the students' mean score indicating their science process skills, both in pretest and posttest.

Table 2. The result of science process skill test

Average description	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
The number of samples	32	32	32	32
Deviation standard	9.81	19.10	10.21	13.89
Maximum score	46.60	100.00	50.00	100.00
Minimum score	13.30	33.30	13.30	50.00
Mean	30.17	70.16	34.45	79.33
The increased average	39.99 %		44.88%	

Referring to the data presented in Figure 1, it shows that there are differences in the average pretest of the control class and the experimental class of 4.28. Even so the average of the control class and experimental class posttest which showed a difference of 9.17. These results indicates that the guided inquiry with the starter experiment approach showed a higher improvement between the experimental class and the control class that did not implemented guided inquiry learning with the starter experiment approach.

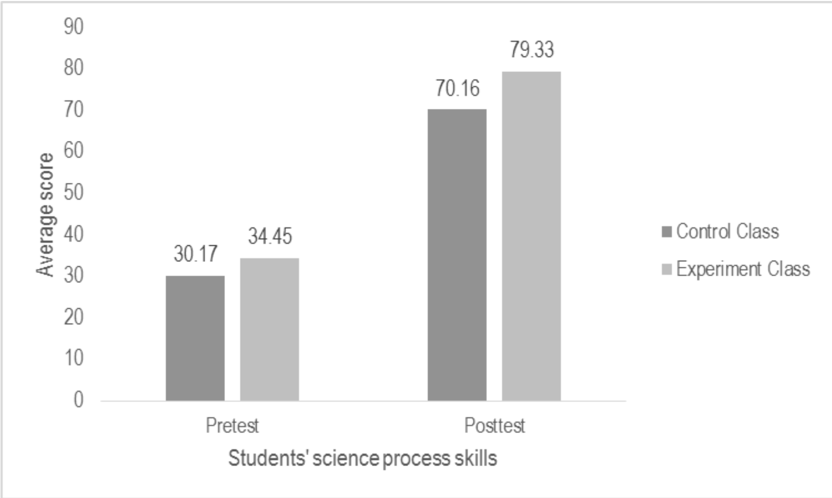

Figure 1. The mean score of the students' science process skills

Normality test results (Table 3) show that the probability (sig) > 0.05 both in the control class (0.119) and experimental class (0.90). These results indicate that the data is normally distributed. Furthermore, the homogeneity test results indicate that the probability (sig) > 0.05, thus it can be concluded that the data are homogeneous (Table 4).

Table 3. The Result of normality test of science process skill

Class	Significance	Data distribution
Control	0.119	Normal
Experimental	0.90	Normal

Table 4. The result of homogeneity test

Data	Significance	Data variance
Science process skill	0.552	Homogeneity

Based on the results of the prerequisite test, the data analysis of science process skills have met the criteria, both normality and homogeneity. Therefore, the analysis is continued to the hypothesis test using analysis of covariance (ANCOVA). ANCOVA test results as shown in Table 5.

Table 5. Analysis of covariance of science process skill

Source	Mean square	F	Sig
Intercept	357633.901	1272.73	0.000
Science process skill	20.285	0.72	0.789
Treatment	1482.698	5.27	0.025

The ANCOVA test results in Table 5 show that the significance is $\alpha < 0.05$ (0.025). This shows that the alternative hypothesis (H_1) is accepted, thus there is a significant difference between the treatment of guided inquiry and the starter experiment approach in the experimental class with the control class.

The result of data analysis on the effectiveness of guided inquiry with starter experiment approach can be seen in the descriptive data of the students' science process skill. The descriptive data showed that there was an increase in the mean score of the students' science process skill. The result of posttest in the experimental class was 79.33. whereas the control class was 70.16. The effectiveness of guided inquiry with the initial experimental approach is indicated because of teacher guidance so that students are conditioned to think and find solutions to the problem (Gumilar et al., 2019; Jado, 2015). Therefore. students can understand how to solve and manage problems by utilizing their skills (Rusche & Jason, 2011).

By optimizing thinking skills, students can develop their science process skills. Related to Mutammimah et al. (2019) which emphasizes that the process of science is a skill that fundamentally requires higher-order thinking skills. These skills are certainly not only the result of remembering but also the results of questions and problems that students develop themselves (Jocz, Zhai, & Tan, 2014; Liu, He, & Li, 2015). In this context. the role of the teacher is limited to facilitating students in learning (Rajagukguk & Simanjuntak, 2015).

Therefore, the growth of science process skills students play a large role as motivation for students to find facts and concepts based on theory.

The learning process that engages the students' active roles in its process can advance the students' science process skill (Akyol, Sungur, & Tekkaya, 2010; Musawi et al., 2012). Students are encouraged to actively think, communicate, and socialize, which lead them to succeed. Students are encouraged to actively think, communicate, and socialize, which leads them to succeed. The experimental class is stimulated to find problems, formulate research problems, make hypotheses, and answer questions independently. During the treatment process, the students were energetic in doing experiment and sharing the results.

The implementation of the starter experiment approach and guided inquiry enables students, both independently and in groups, to be involved in the science process. The philosophically based experimental approach provides opportunities for students to study comprehensively (Madhuri, Kantamreddi, & Prakash-Goteti, 2012; Newman, 2015). The orientation of learning in the experiment-based approach mainly emphasizes knowledge (Syla & Hodolli, 2017), reconstruction (Iversen, Pedersen, Krogh, & Jensen, 2015; Thompson, 2011), application (Gultepe, 2016), understanding (Cremin, Glauert, Craft, Compton, & Styliandou, 2015), observation from various perspectives (Rahmasiwi et al., 2015), and built the new concepts (Aflalo & Gabay, 2013).

These repetitive learning activities enable students to develop thinking patterns in the science process. Furthermore, students can think more comprehensively so that they hypothesize a problem. Hypotheses made in several perspectives ultimately make it easier for students to conduct experiment to find answers to these problems and make decisions (Dwyer, Hogan, & Stewart, 2014; Gay, Mills, & Airasian, 2012). In addition, Musawi et al. (2012) said that process skills can help students develop fundamental ideas in conducting investigations, interpreting, and making conclusions about a problem.

The results of this study indicate that science process skills can be optimized with inquiry learning models based on the experimental approach. Furthermore, Abungu et al. (2014) explained that the direct experience gained by students through these experimental activities is crucial basis for long-term memory. This is in line with the opinion of several previous studies which reported that inquiry learning allows students to form a comprehensive understanding (Rusche & Jason, 2011). The results of this study recommend that learning with a guided inquiry model with a starter experiment approach be developed according to the characteristics of the material being taught.

CONCLUSION

The results showed that the guided inquiry model with a starter experiment approach effectively had a significant impact in improving students' science process skills. The repetitive experimental approach provides complex thinking spaces for students to develop their thinking skills. This has an impact on improving science process skills. This study recommends that teachers use a learning model based on an experimental approach, according to the characteristics of the material being taught.

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