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The Effect of Inquiry-Based Learning Model by Jas Approach on Students' Scientific Process Skills

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Abstract

This study aimed to determine the effect of guided inquiry-based learning model with Natural Environment Exploration (JAS) approach on the topic of sensory system on student's Sciencetific Process Skills (SPS) as well as determining the increase of students' SPS. The type of this study was quasi-experimental with non-equivalent control group design. Subjects in this study were students from grade XI of class MIA 4 as the control and XI MIA 5 as the treatment group. The independent variable was the guided inquiry-based learning model with JAS approach on the topic of sensory system, while the dependent variable was students' SPS. Students' SPS was measured by pre-test and post-test consist of 30 questions. The result of data analysis showed that the guided inquiry-based learning model with JAS approach had a significant effect on students' SPS, with the value of determination coefficient at 0.374. Students' SPS increased after the treatment with the average N-gain of treatment group at 0.27. The result of the study concludes that the implementation of guided inquiry-based learning model by JAS approach on the topic of sensory system affects and increases the students' SPS, especially in the aspect of interpreting data, communicating, designing experiment, formulating hypotheses and classifying.

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INTRODUCTION

Scientific Process Skills (SPS) are the thinking skills used to build the knowledge to solve problems and formulate the results (Özgelen, 2012). Haryono (2006) revealed that SPS is very important in education as the basic competencies to develop students' scientific attitude and problem-solving skills in an attempt to build creative, critical, open-minded, innovative and competitive persons in global competition.

The preliminary study showed that high school students' SPS were still low and need to be improved. This could be seen from the results of The Trends in International for Mathematics and Science Study (TIMSS) survey in 2015 reported that Indonesia was in a position below the average (45^{th} rank of 48 countries) for the science category. In addition, the results of the Program for International Student Assessment (PISA) program put Indonesia in the position of 69 out of the 76 participating countries (OECD, 2016).

The low level of students' SPS can be caused by the less appropriate learning model used by the teachers as stated by Kurnia & Fathurrohman (2014), and the assessment of students' SPS was rarely done, so the students did not feel the need to master the SPS. The results of observations and interviews with teachers of Biology class XI SMA Negeri 1 Bergas supported the statement that students' SPS on Biology subjects are rarely measured. In addition, the method often used by teachers in learning Biology is a lecture method. The lecture method is allegedly less able to facilitate the students to develop the skills of the science process so that the process skills possessed by students are still low.

The guided inquiry model has a positive impact on building the attitudes (Bilgin, 2009), improving the ability to applying and analyzing on science subject (Harmiyanti, 2016). It can also enhance students' SPS (Saputra *et al.,* 2012) especially in Biology (Ghumdia & Adams 2016).

The guided inquiry learning model needs to be complemented by appropriate learning approaches. One approach that can be used is the Natural Environment Exploration (JAS). Learning with JAS approach which has six components (exploration, constructivism, science process, learning community, bio edutainment, and authentic assessment) is one alternative to improve students' SPS (Ismartoyo&Indriasih 2013). The implementation of JAS approach to Biology learning will make the learning become more effective and efficient (Alimah *et al.* 2016).

The guided inquiry learning model with its six syntaxes integrated with JAS approach is expected to be a blend of instructional design that can make students interact directly with biological objects as well as improve students' SPS. By having sciencetific process skills, students will be easier to understand the complex and abstract concepts because they are accompanied by concrete examples through the real objects. Students will learn actively and creatively in developing skills of concepts acquisition. SPS can also facilitate students to practice asking questions, think critically, promote physical and mental skills. SPS acts as a vehicle to merge the development of student concepts with the development of attitudes and important values as a provision to the challenges especially in this 21st century.

The topic studied in this research was the sensory system for XIth graders. In this topic, there are concepts that must be studied and completely understood by high school students . It contains issues closely related to the daily events of students. Students must have the SPS to make it easier to understand and find the concept of the sensory system. This study aimed to determine the effect of the implementation of guided inquiry-based learning model with JAS approach on the sensory system material to the science process skill of high school students and to determine the raise of students' SPS caused by the treatment.

RESEARCH METHOD

The research method was quasi-experimental with non-equivalent control group design. The population of this study was the XIth graders of SMA Negeri 1 Bergas in academic year 2016/2017 with the sample classes were XI MIA 4 and XI MIA 5. Samples were determined by purposive sampling technique.

The independent variable of this study was guided inquiry model with JAS approach, while the dependent variable was SPS consisting of nine aspects (applying concepts, predicting, interpreting, communicating, asking questions, planning experiments, formulating hypotheses, observing and classifying). The primary instrument used to measure the SPS was a test with 30 questions. Supporting instruments include observation sheets, questionnaires, and interview sheets.

Data were analysed by regression test to determine the effect of guided inquiry-based learning model with JAS approach on students' SPS and N-gain test to determine the raise of students' SPS before and after the treatment.

RESULTS AND DISCUSSION

The data obtained from this research were the students' SPS and the value of learning implementation using guided inquiry-based learning model with JAS approach. The SPS was from pre-test and post-test score. A pre-test was given to measure students' early SPS, both in the control and treatment group. While, a post-test was used to measure students' SPS after the treatment. Results of student pre-test and post-test are presented in Table 1.

Table 1 The Result of Pre-test and Post-test in both Control and Treatment Group

Data Statistik	Eksperimen		Kontrol	
	Pretest	*Postes*	*Pretest*	*Postes*
Number of students	36	36	38	38
Average score	68,11	77,28	67,26	72,95
Highest score	82	86	82	86
Lowest score	52	64	50	55
Median	69,00	77,00	68,00	73,00
Standard Deviation	6,87	5,39	8,86	7,82

Based on Table 1, it can be seen that the mean score of pre-test and post-test between the control and treatment classes are different. The average score of pre-test in the treatment and control class were 68.11 and 67.26 respectively. The average score of post-test obtained by the treatment class (77.28) was higher than the control class (72.95). The score of pre-test and post-test of both control and experiment class were then analyzed by using a t-test to determine whether there is a statistical difference of pre-test in control and treatment group as well as the post-test score or not. The t-test was performed after the performance of normality and homogeneity test that showed that the data were normally distributed.

The t-test used was Independent Sample t-test on SPSS version 18. Based on the result of data analysis, it was known that the significance value (sig. 2-tailed) was 0.648> 0.05. This means that there was no difference in the students' SPS between the treatment and control class, it can be concluded that before the treatment, the students depart from the same SPS level.

Based on the result of t-test analysis on the treatment and control class, it was known that the significance value (sig. 2-tailed) was 0.007 <0.05. This means that there was a difference in the students' SPS between the treatment and the control class, it can be concluded that after the treatment students have different SPS.

The differences in the mean score of students' SPS in treatment and control were caused by the effects of sensory system learning by using guided inquiry-based learning model with JAS approach. The magnitude of the influence provided by the guided inquiry-based learning model with JAS approach to students' SPS was calculated using the regression test.

The result of regression test showed that there was an effect of guided inquiry-based learning model with JAS approach to students' SPS. This can be seen from the amount of determination coefficient (0.374), which means that the SPS was influenced by the use of guided inquiry model with JAS approach by 37.4%, while 62.6% is the influence of other factors not examined in this study.

The implementation of guided inquiry-based learning model with JAS approach gives improvement to students' SPS, as shown in Table 1. The magnitude of the increase in pre-test and post-test of SPS in the treatment and control class was calculated using N-gain and continued with t-test to determine the difference in the rise of SPS.

Based on the result of t-test analysis on the N-gain value of treatment and control class, it was known that the significance value (sig. 2-tailed) was 0.008 <0.05. This means that there was a significant difference between students' SPS in both treatment and control class. It can be concluded that the treatment (learning process) have increased the students' SPS.

The increase of the students' SPS is influenced by the application of guided inquiry-based learning model with JAS approach. During the learning activities, students conducted a lab work and discussion in groups about the 5 organs of sensory systems using tools and materials derived from the environment around the students. The guided inquiry-based learning model with JAS approach supports the development of students' SPS because it has an integrated learning cycle between theory and practice, and emphasizes the importance of continuous learning. This is consistent with cognitive experts who stated that students need to connect new ideas with their experiences and put new ideas in their frame of mind (Bransford *et al.* 2001).

The guided inquiry-based learning model with JAS approach is a learning model that trains students to seek the concepts as well as understand and apply those concepts in everyday life through the practicum of sensory systems. The guided inquiry-based learning model with JAS approach includes six syntaxes, whereby all six syntaxes are integrated with the JAS approach component. The syntaxes will stimulate students' SPS as revealed by Karamustofaoglu (2011) that the science learning process that develops the mastery of knowledge and concepts can improve students' SPS. The description of the syntaxes of guided inquiry-based learning model with JAS approach is presented below.

Orientation

The first syntax is the orientation. Students in the group discussed the problem related to the sensory system presented by the teacher. The problem given was a real problem and close to the daily life of the students. It facilitated the students in solving the problem because the students had met the problems directly. This syntax is integrated with the component of JAS approach: constructivism, community learning, and authentic assessment. This first syntax will trace the SPS in term of observation and asking questions skills.

Formulating Problems

The second syntax is formulating the problem. Students in groups would do the process of discussion to write down the formulation of the problem in accordance with the problems that have been presented in the orientation stage. In this syntax, students' ability to write problem formulas in sentences that indicate the relationship between one variable with another variable will be assessed.

Students are required to be able to write a sentence in accordance with the rules of proper grammar and show the relationship between variables to know the answer. The components of JAS integrated into this syntax approach are constructivism, community learning, science process and authentic assessment. The syntax trains the SPS in the form of questioning and communicating skills.

Formulating Hypotheses

In this syntax, students were asked to discuss the formulation of the hypotheses in accordance with the formulation of the problems that have been prepared previously. Students are encouraged to look for answers to questions that have been previously written by looking for references from any source, such as books or information from the internet. Students need to have an active discussion to find the right answer with a trusted reference source. Through the brainstorming, students will be more able to determine the exact answer to the problem. The components of JAS integrated into this syntax are constructivism, community learning, the process of science and authentic assessment. The third syntax trains the SPS in the form of predicting, formulating hypotheses and communicating skills.

Collecting the Data

The fourth syntax is collecting the data. Students would test whether the hypothesis they have compiled is acceptable or not. The teacher would guide the students in collecting the data. In this syntax, students performed the practicum of sensory systems using tools and materials derived from the environment around the students. For example, for the sense of smell, students used various herbs to test their sense of the smell. Students sought as much information as possible from their sensory system practicum to answer the formulating problem. Students also seek the information related to the topics from various other sources (books, the internet, or from the experiences they have previously acquired). In the fourth syntax, the integrated components of the JAS approach are exploration, community learning, science processes, bio edutainment and authentic assessment. The fourth syntax trains the SPS in the form of designing experiment, observing and classifying skills.

Formulating Hypotheses

The fifth syntax is formulating hypotheses. Students in groups answer the questions contained in the Student Discussion Sheets and present the results of the discussion in front of the class. The teacher asks questions and invites students to come together to discuss the results of the work. In the fifth syntax, the integrated components of JAS are exploration, community learning, science process, bio-edutainment and authentic assessment. The fifth syntax trains the SPS in the form of conceptualizing and communicating skills.

Formulating the Conclusions

In this sixth syntax, students and the teacher held an evaluation of the learning that has been implemented, so it can be known whether the students can do the learning activities well or not. After the evaluation was completed, the students along with the teacher concluded the results of practicum they have performed. In this syntax, the integrated component of JAS is exploration, community learning, science process and authentic assessment. The sixth syntax trains the SPS in the form of interpreting, applying concepts, classifying and communicating skills.

As a supporting data, the SPS in the treatment class were also measured through the questions on the Student Discussion Sheet (SDS) about sensory system practicum. The ability of students in answering and completing SDS was used as a means to train SPS in the treatment class. The result of the SDS assessment shows that the treatment class obtained an average SDS score of 75. During the practicum and discussion activities, the observer observed the students' SPS as well as scoring the students in treatment class. The result of observation of the SPS shows that the treatment class obtained an average score of 78.

In the treatment process, SPS was raised at each stage of guided inquiry-based learning model in which integrated with JAS components. This model presented the learning concept of a sensory system that was more meaningful and provided opportunities for students to learn more deeply. The significance of the knowledge possessed by the students is inseparable from the teacher's role which presents questions about the problems which are common in the daily life of the students. That kind of problems will make students have a high interest and curiosity to solve the problem. Curiosity is a motivation that comes from within students and will trigger students to try (Beswick, 2000).

The problems generated at the beginning of the learning process requires students to learn to apply the concept and link the concept with another concept which will produce a more meaningful and useful concept. The concept of knowledge construction by students will then be stored in long-term memory if the new information that has been formed matches the information they have previously (Alimah & Marianti 2016). The activity of linking and applying concepts will help students to become more skilled with the SPS.

The increase of the SPS acquired by the students is influenced by the application of the JAS approach. The JAS approach combined with the guided inquiry-based learning models requiring students to take an active role in each stage of learning. These activities support the success of learning in the classroom because JAS is one of the learning that is meaningful and fun makes students comfortable in learning. Rauf et al. (2013) stated that the achievement of applied learning could be meaningful if the skills or knowledge of students is obtained through the constructivist approaches and a planned learning environment. Umamah (2016) also stated that group exploration activities based on constructivism could be used as an alternative to a learning process. Fun learning activities can also improve the student learning outcomes and activities (Nilasari *et al.,* 2016). The objectivity of biology learning will occur if the learning also uses appropriate assessment, which is an authentic assessment. Authentic assessment not only drives students in understanding the biological knowledge but also required students to solve problems in everyday life (Pantiwati, 2014).

During the process of learning, students look enthusiastic in the following learning. Students actively asked the teacher when there was a problem or something that they couldn't understand. Students were also actively involved in a discussion, exchanging ideas to solve problems about the sensory system. After the discussion process, students presented the results of the practicum they had done. Through the presentation, students will be encouraged to understand better the problems that had been resolved because they had to present in front of the class, and would further develop the students' skills in communicating especially verbal communication.

The results of this study indicate that the implementation of guided inquiry-based learning model with JAS approach on the topic of the sensory system affects the students' SPS. The variable of SPS is influenced by the guided inquiry learning model variables with JAS approach by 37.4%. Several other factors, both internal and external, also affect the SPS, such as the low science background, the lack of laboratory infrastructure (Jack 2013). The book that used as the only instructional guideline (Ekene & Ifeoma 2011) and the school administration that has not initiated the learning contextual (Chaguna & Yango 2008), emphasizing only the mastery of the concept (Sukarno *et al*., 2013).

Analysis of supporting data in the form of a questionnaire of student responses to guided inquiry-based learning model with JAS approach showed that students thought that the guided inquiry learning model with JAS approach is excellent. In line with this, the results of interviews with Biology teachers also show that the application of guided inquiry-based learning model with JAS approach gives influence to students' SPS.

The results of the research described above are in accordance with those study by Bilgin (2009). Itrevealed that the guided inquiry-based learning model has a positive impact in building attitudes, increasing students 'and teachers' activeness and the ability to apply and analyze on science subjects (Harmiyanti, 2016) as well as improving students' SPS (Saputra *et al.,* 2012) especially in Biology (Ghumdia & Adams, 2016).

CONCLUSION

Based on the result of the research finding, it can be concluded that the implementation of guided inquiry-based learning model with JAS approach on the sensory system topic affects the science process skill of high school students. Its implementation can improve the Science Process Skill of high school students.

The shortcomings of this study are as follow: 1) the preparation of research implementation that should be more considered, 2) the questions used to measure the SPS that should relate to the practicum in order to measure students' SPS accurately, 3) the results of study with the application of guided inquiry-based learning model combined with JAS approach that should be compared with the result of study with only guided inquiry-based learning model (no JAS approach combination) on students' SPS. This limitation can be used as a reference for further research improvement or as advanced research material.

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