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Enhancing Students' Activity and Science Concept Mastery using Guided Inquiry-Based Practical Manual

Ratna Dewi Andriani[1,*], Sunyono[2], Abdurrahman[2]

[1] SMPN 1 Natar, South Lampung, Indonesia.
[2] FKIP, Universitas Lampung, Lampung, Indonesia.

**Corresponding e-mail:* ratnadewi@gmail.com

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Abstract: Enhancing students' activity and science concept mastery using guided inquiry-based practical manual. This quasi-experimental research aimed to understand the effectiveness of guided-inquiry based practical manual for improving students' activity and concept mastery of science. Sixty students from SMP Negeri 1 Natar were selected as research samples in this study. This research used two types of data that were quantitative data (pretest, postes, and n-gain) and qualitative data (learning observation and student activity). The results showed that high n-gain score (0.70) for both experimental class 1 and 2. In addition, the assessment of student activity in experimental classes 1 and 2 is also quite good with the score is 86.44% and 85.84%, respectively. Therefore, the use of guided inquiry-based practical manual is highly recommended to improve student's learning activity and mastery of the science concept.

Keywords: Practical manual, guided inquiry, student's activity, science concept mastery.

Abstrak: Meningkatkan aktivitas siswa dan penguasaan konsep sains menggunakan buku penuntun praktikum berbasis inkuiri terbimbing. *Penelitian kuasi eksperimen ini bertujuan mengetahui keefektifan penggunaan buku petunjuk praktikum berbasis inkuiri terbimbing dalam meningkatkan penguasaan konsep IPA. Sebanyak 60 orang siswa SMP Negeri 1 Natar terpilih secara random sebagai sampel pada penelitian ini. Penelitian ini menggunakan 2 tipe data yaitu data kuantitatif (pretes, postes, dan n-gain) dan data kualitatif (observasi keterlaksanaan pembelajaran dan aktivitas siswa). Hasil penelitian menunjukkan bahwa perolehan n-gain yang cukup tinggi pada kelas eksperimen 1 dan 2 yaitu 0,70. Disamping itu, penilaian aktivitas siswa pada kelas eksperimen 1 dan 2 juga cukup baik dengan perolehan nilai berturut-turut adalah 86,44% dan 85,84%. Oleh karenya, penggunaan buku petunjuk praktikum berbasis inkuiri terbimbing sebagai suplemen belajar siswa sangat dianjurkan untuk dapat meningkatkan aktivitas belajar dan penguasaan konsep IPA.*

Kata Kunci: *Buku petunjuk praktikum, inkuiri terbimbing, aktivitas siswa, penguasaan konsep sains.*

INTRODUCTION

Science concept mastery and students' activities are the most important educational issues in Indonesia, besides thinking skills. The results of the Trend International Mathematics Science Study (TIMSS) study on the achievements of science show that Indonesian students are ranked 40 out of 42 countries in 2011 and 36 out of 49 countries by 2015 (Marthin, 2012). The findings of PISA and TIMSS show that science education in Indonesia is still at a low level so it is necessary to improve the quality of education (Mullies et al., 2016; Marthin, 2015).

There are many methods or approaches that can be used to improve the quality of learning science. However, some experts suggest that science should be learned in accordance with how the concept of science itself is obtained (Windschitl et al., 2008). The concept of science is obtained through a series of scientific processes such as: observing phenomena, hypotheses, and experimenting to test hypotheses (Lederman, 2006). One of the methods of learning that suits the characteristics of the scientific process is inquiry-based learning.

The implementation of inquiry-based learning has proven to be effective in improving students' performance in learning science (Gormally et al., 2009). Simsek & Kabapinar (2010) found that the implementation of inquiry method improves scientific process skills, conceptual understanding, and students' attitude towards science. Furthermore, the inquiry method proved that this method can increase students' engagement and activities in the classroom (Prince & Felder, 2006) as well as in laboratory experiments. The Ministry of Education of Indonesia through the National Board of Education Standard (2006) has instructed that all teaching and learning activities should involve inquiry process.

Learning science through inquiry methods will invite the students to prove the hypotheses through a series of experiments. Through the practice itself, students will be more explorative and directly involved in knowledge-seeking or concept-proof work. Then, they will gain stronger knowledge and last longer in students' memory than simply receiving information from teachers and books (Bruno, & Dell ' Aversana, 2018; León-Montoya et al., 2018). In addition, the students' role in the lab can enrich the experience and develop students' scientific attitude (Cartwright, & Hallar, 2018). According to Cian et al. (2018), there was a significant increase in cognitive ability after students followed the learning with practicum activities.

The effectiveness of the practicum activities depend on the instructions given by the practicum guide. The practical manual contains procedures for preparation, implementation, data analysis, and reporting. The practicum guidebook should be clear, effective, and easy to understand. Nevertheless, some educational researchers in Indonesia found that the practical guidebook used in Indonesian schools has many shortcomings (Suwono et al., 2017). The guidebooks are not developed by teachers but from certain publishers that are not qualified in designing and do not train the students' inquiry skills (Susanti et al., 2017). Therefore, an inquiry guidebook is needed in order to facilitate the student's inquiry process effectively.

The development of self-directed practical books on various topics have been conducted in various schools in Indonesia (Nugroho et al., 2018; Ulandari, 2018). Nevertheless, the author has not found a study of the development of an inquiry-based practicum book on the topic of Motion on Living Things and Objects. This topic is a topic that must be taught in science class SMP VIII as an introduction to the concept of physics.

Based on the description and aforementioned theoretical background, this research is aimed to know the effectiveness of the use of guided inquiry guide-based manuals in improving the mastery concept on the topic of Motion on Living Things and Objects. The guided inquiry was applied in this study because of the consideration that inexperienced research samples were studied using the inquiry method.

METHOD

This quasi-experimental research with the pretest-posttest design was implemented in Natar, South Lampung Regency, Lampung Province, Indonesia. Lampung Province as one of the provinces at the end of Sumatra is one of the provinces with teachers' competency test scores below the national average score. The sample was 60 students of the second grade of Junior High School 1 Natar Lampung Selatan by random sampling technique.

The application of inquiry-based guidebooks was conducted in two experimental classes. In the experimental class 1, the learning was done by the researcher while the experimental class 2 learning was done by the science teacher of Junior High School 1 Natar. This aimed to observe whether the mastery of the concept was only influenced by the practicum book or there was an influence on the ability of the instructor.

The data were collected by using a test instrument about the concept of science mastery in the form of multiple choice in 15 questions, the observation sheet of learning implementation, and the observation sheet to see the students' activity. The instruments used are developed by the researcher by considering the expert judgment regarding the instrument content.

The data were analyzed in a descriptive quantitative to calculate the score of n-gain as the indicator of improvement of students' science mastery concept. The n-gain score is calculated using the Hake (2002) formula:

$$n - gain = \frac{\%\text{ posttest score} - \%\text{ pretest score}}{100 - \%\text{ pretest score}}$$

with n-gain < 0.3 means low of students' concept mastery, 0.3 < n-gain < 0.7 means average and n-gain > 0.7 means high.

The scores of instructional learning are calculated by using the formula:

$$\% J_i = \frac{\sum J_i}{N} x\ 100\%$$

Which %*Ji* shows percentage of achievement from score ideal for every aspect observation at the ith meeting, *ÓJi* is total score of each aspect observations are given by observer at the i-th meeting and N is maximum score (ideal score). The score of students' activities is calculated by using this formula:

$$\%Pa = \frac{Fa}{Fb} x\ 100\%$$

which $P\text{-}_a$ is percentage of students' activity in the class, F_a is percentage of the average students' activities, and F_b is the average of the frequency of student' activity being observed.

RESULTS AND DISCUSSION

The result of this research consisted of concept comprehension data, students' involvement in the laboratory, and students' activity. The results showed that the two experimental classes had high n-gain pretest and posttest averages as shown in Table 1. The improvement of conceptual mastery in the two experimental classes occurred because learning using guided inquiry model can make the students actively involved in the learning process (Gormally et al., 2009). In addition, the implementation of guided inquiry model can directly train scientific skills such as observing, asking, trying, searching, investigating, reasoning and communicating.

Table 1. Pretest score, posttest score, and n-gain for both experimental classes

Exp. class	Mean pretest (±sd)	Mean posttest (±sd)	n-gain
E1	48.55 (±10.09)	84.68 (±7.41)	0.70
E2	50.67 (±10.97)	84.83 (± 6.63)	0.70

with E1 is Experimental class 1, E2 = Experimental class 2, and sd is standard deviation.

In addition to the mean score of the pretest, posttest, and n-gain values, students' mastery science concepts are also supported by an increase in the mean value per mastery concept indicator as presented in Table 2.

Table 2. Mean score of *n-gain* mastery concept

Indi.	E1		E2	
	n-gain	criteria	n-gain	criteria
C1	0.43	S	0.29	L
C2	0.64	S	0.57	A
C3	0.78	T	0.64	A
C4	0.68	S	0.72	H

with Indi. is indicatior, C1 is remembering; C2 is understanding, C3 is applying, C4 is analyzing, L is low, A is average, H is high.

Table 2 provides the information that the gain of the concept n-gain value on the indicator considering in the experimental class 1 is 0.43 with the medium criterion and in the experimental class 2 of 0.29 with the low criterion. The high percentage of achievement in the "remember" indicators in the two experimental classes is due to the fact that students have not improved their way of learning like doing repetition of material when at home. Efforts that must be done by the teacher is to guide students as in the stage of stimulation contained in guided learning inquiry model.

In the first stage of orientation, students are invited to think and stimulate their relevant knowledge to find problems in learning based on the discourse or phenomenon presented. Students are ready to carry out the learning process because at this stage the teacher creates the atmosphere or bring responsive learning. Teachers ask and stimulate students to think about solving the problems in learning. At this stage, students are involved in learning so that students are motivated to be active in learning activities.

Almost all students are able to find the problem, but there are still groups that take longer than the other to find the problem. Furthermore, there are group discussion activities, allowing students to have opportunities to express their opinions and ideas, learn with strategies and prepare better learning outcomes. Khhaza (2015) in his research concluded that students working in groups gain better in learning outcomes. Group discussions give students the opportunity to express their opinions and ideas, learn with strategies and prepare them for work in the real world. This process is ultimate can assist students in enhancing the mastery of student concepts, as evidenced by the acquisition of n-gain values in experimental class 1 of the experimental class 2.

In addition to providing basic explanations, the ability to develop during the learning process is to build basic skills. Improved basic skills building skills develop as students enter the stage of formulating problems, submitting hypotheses, and collecting data. Students are trained and challenged to think solving the puzzles in learning problems. Thinking of solving the puzzle in the problem formulation is studied because the problem is certainly unanswered, students are encouraged to find the right answer. This process makes students gain valuable experience as an effort to developmental through the process of thinking and can improve the students' mastery concepts.

During the learning process, student and teacher-student interactions work well. In this case, the interaction between teacher and student is very important and becomes one of the determinants of the effective inquiry process during the laboratory (Cheon & Reeve, 2015; Gillies & Nichols, 2015; Loima & Vibulphol, 2014). The teacher plays as a facilitator during the learning process, whether the interaction between students and students and the interaction between students and teachers, so that teachers and students can work together to formulate the problem. Hattie (2013) charts that the percentage of teacher roles on student achievement is 30%, as much as 50% is influenced by the students themselves and the remaining 20% is affected by peer groups, school environment, leadership, and home. Teachers who are competent in managing inquiry learning will greatly affect students' academic performance (Blanchard et al., 2010; Bruce et al., 2010).

When the students are asked to submit a hypothesis, there are still many students who have difficulties, so the teacher should provide direction to students in order to be able to propose the hypothesis well. In this case, the teacher guides the students by inviting the students to think how to estimate the right answer, based on the result of the strong thinking so that the proposed hypothesis is rational and logical. This is in line with the statement of Gaddis (2007) that Teachers have an enormous role in guiding and controlling information obtained by students in learning so that students can easily understand a concept because they have enough time to think deeper.

In the third stage of collecting data through practicum activities filled by the number of students who ask about the practicum procedure for fear of making mistakes at the time of the lab. Therefore, the deserts play an active role to help guide and guide students in practicum activities, in order to obtain the data needed to test the proposed hypothesis. In the implementation of guided inquiry learning the teacher should not just let go of the activities of the students, but teachers must provide direction and intensive guidance to students in conducting activities.

In the fourth stage of data processing, students work together to process the data and develop the ability to apply or use information that has been obtained through discussions with friends in the group in solving problems related to experiments that have been done. This process is able to increase the mastery of student concepts on indicators applying with high criteria in both experiment classes. This is in accordance with the results of research Keys & Bryan (2001) that also increased. This is consistent with the results of the Lestari (2009) study that the students' activeness is actively involved in analyzing the data, actively working together in teams organized by the discovery method more effectively for the students in correlating the various concepts.

Table 3. Results of observation of the implementation of learning

Model and Component of Observation	E1			E2		
	Scoring		Achievement (%)	Scoring		Achievement (%)
	Observer 1	Observer 2		Observer 1	Observer 2	
Syntax	88.89%	83.33%	86.11%	77.78%	83.33%	80.55%
Social system	86.67%	86.67%	86.67%	86.67%	80.00%	84.98%
Reaction principal	80.00%	86.67%	83.35%	86.67%	86.67%	86.67%
Average score			**85.38%**			**84.04%**

At the stage of testing the hypothesis students in groups to discuss by answering the questions that exist in the manual laboratory. Working in groups and discussing problem-solving during the learning process can help the students in obtaining better learning outcomes. The same thing expressed by Khazaal (2015) in his research concluded that students who work in groups get better learning outcomes.

In the sixth stage of conclusions or generalizations, there are still groups that take longer than other groups to conclude the findings. This is because the students are not accustomed in making their own conclusions by using their own sentences by paying attention to the results of the verification, so that is where the teacher acts as a facilitator and helps students in improving the sentence arrangement to the conclusion.

The next meeting of this stage went smoothly, the students no longer have difficulty and active in every activity. It is as revealed by Dopplet (2003) that active students will be responsible for the tasks in their group and gain experience learning on every activity undertaken, and this makes the student a clever student.

The improvement of student's conceptual mastery in the two experimental classes is also supported by the implementation of learning using guided inquiry ledger manuals observed by two observers during the learning process. Results observations are presented in table 3

Table 3 provides information that the assessment given by two science teachers as observer 1 and observer 2 shows that all aspects (syntax, social system, reaction principle) achievement included in very high category which means the implementation of learning by using instruction manual of inquiry the guidance observed in the experimental class 1 included is in the very high category.

Overall, implementation of guided inquiry based practical manual has been compatible with the guided inquiry guilt synthesis. Besides being supported by instructional learning, the improvement of student's concept of mastery is also supported by very high learning activities. During the learning, all student activity is observed by the observer. The result of observation on student activity is shown in Figure 1.

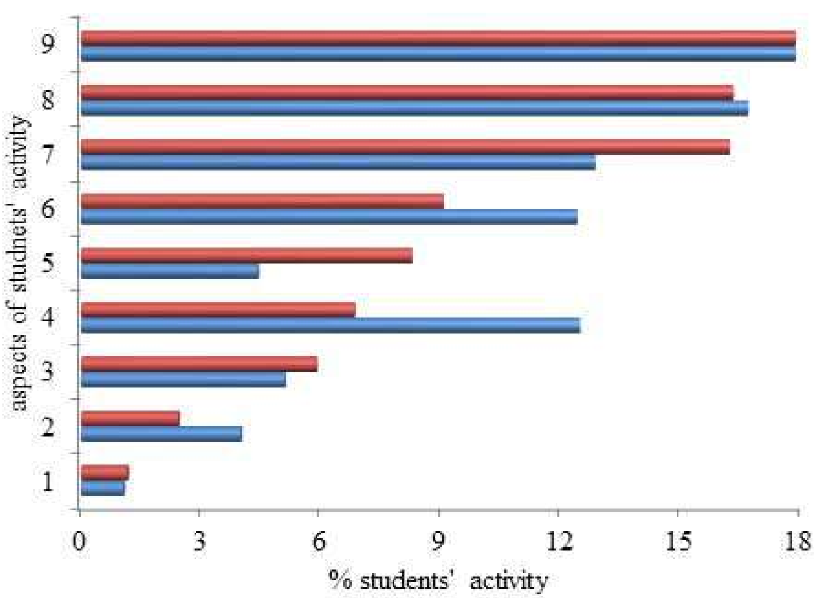

Figure 1. Students' activity in learning activities [experimental class 1 (blue); experimental class 2 (red)]

The aspects of student's activity observed are (1) pay attention and listen to the explanation of teacher and friend, (2) browse the information through textbook which have been provided, (3) discussion or ask answer between student and friend, (4) (7) commenting on the presentation of other students, (8) reviewing the teacher's work, (9) listening to the teacher's work, correction or teacher's response to the material being studied.

Based on image data 1, it is found that the total percentage of student activity frequency is 86.44% for experimental class 1 and 85.84% for experimental class 2. From the nine aspects observed, the student is the highest in the listening activity of teacher correction or responses to the learned material and activity the lowest is on paying attention to and listening to teacher or friend explanations.

It can be said that students have been paying attention and listening to the explanation or correction or strengthening of the teacher about the material being studied, reading the information through textbooks, discussing and asking questions between the students and between the students and the teacher is very active. Students also actively involve themselves in group practice activities and are active in responding to questions in practical manuals and commenting or responding to other students' presentations. These results are consistent with the findings of Matthew & Kenneth (2013) indicating that students taught using guided inquiry methods have better achievement scores than students who learn by using learning methods.

The use of guided inquiry guide-based manuals creates a new and exciting learning environment. Students feel good when the practical manual is used during classroom teaching because they understand how to design a science experiment with simple, easy to understand, easy to implement experimental steps. The use of guided inquiry ledger manual also makes students experience a number of new habits that can increase the activity and mastery of student concepts, such as learning to find their own information through relevant literature, used to express opinions, ask questions and answer in discussion activities. Bringuir (Holzer 2000) states that knowledge must be built on the habits of student learning and can not be given directly by the teacher. Similar matters are expressed by So et al. (2010) that the student activity in learning is not enough just to hear and record as is common in traditional schools, but the atmosphere of learning is fun, passionate and memorable for student to make student's activity increase.

Through the application of the guided inquiry learning model, the students are very actively involved in the learning process. Guided inquiry learning to make learners more enthusiastic in following the learning, skillful experiments, and improve the ability to ask questions.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that (1) guided inquiry guide-based manuals are able to improve students' concepts mastery. This can be seen from the average gain of n-gain in the two experimental classes indicating high criteria. (2) The implementation of learning and student activities in learning is very high. (3) learning by using guided inquiry instructional manual is effectively used to improve mastery of science concept especially on motion material on living creature and object.

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