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THE MANY LEVEL OF INQUIRY: DIFFERENCES IN EFFECTIVENESS TO IMPROVE LEARNING OUTCOMES AND PROCESS SKILLS OF LEARNING PHYSIC IN SENIOR HIGH SCHOOL

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Abstract

This study aims to investigate the differences in the effectiveness of the inquiry learnings of level 2, level 3, and level 4 in improving the cognitive learning outcomes and the process skills of the students. This study could add teacher's knowledge about learning to use some level of inquiry, so that it can be applied in the learning process. Pretest-posttest non-equaivalent control group design was used for this quasi experiment research. A sample of three group was established using the cluster random sampling technique. The three classes were assigned as an experimental group 1, experimental group 2, and control group. While the students of the experimental group 1 were taught using the inquiry learning of level 3 (ILL-3), the students of experimental group 2 were taught using the inquiry learning of level 4 (ILL-4) and the students of the control group were taught using inquiry learning of level 2 (ILL-2). The data analysis used MANOVA then processed with further testing using Post Hoc Tukey HSD.

The results of this study show that there are significant differences in effectiveness among inquiry learnings of level 2, level 3, and level 4 in improving the cognitive learning outcomes and the process skills of the students, it is shown by the output value of the F-test (12,50) at the significance level of 0.00 (significance < 0.05). Inquiry learning of level 3(ILL-3) more effective than inquiry learning of level 2 (ILL-2), and level 4 (ILL-4) in improving the cognitive learning outcomes and the process skills of the students, it is shown of gain score. Accordingly, It shows that teachers can implement inquiry learning at a level appropriate to their ability and level of experience of the student's science in improving cognitive learning outcomes and process skills for later upgraded to the next level.

Keywords: level inquiry, cognitive learning outcomes, process skills

INTRODUCTION

Inquiry-based learning has been widely discussed in education policy in Indonesia. Inquiry-based learning became one of the alternatives that can be used to support the new curriculum, which has implemented a scientific approach to learning in each subject. One of the subjects using a scientific approach is physics. Learning physics in high school aims to make students able to master the concepts of physics and their interrelationships, as well as being able to use the scientific method which is based on a scientific attitude to solve the problems (Mundilarto, 2002, p.5). Inquiry-based learning is a process to obtain and receive information by observation, or experiment to find an answer to a question or solve a problem or formulation of the problem by using critical thinking skills and logical (Jauhar, 2011: 65). In inquiry learning, knowledge that is commonly used in the form of principles,

concepts and theories along with science process skills, to build an explanation of natural phenomena so that they understand the science (Glasgow et al., 2010, p.48).

Inquiry learning involves the exploration of the world using scientific knowledge, ask questions, make discoveries, and test the discoveries in the search for new understanding (Fang et al., 2010, p.3; Meador, 2010, p.5; Simsek, 2010, p. 193). All activities are carried out in inquiry-based learning is not only to contribute in improving the skills and attitudes (Ergul et al. 2011, p.48), but also it can improve the cognitive learning (Asyhari, 2014, p.73), critical thinking (Shaheen et al. 2015, p.382), interest and motivation (Avsec & Kocijancic, 2014, p.1436, Purwanto, et.al.2013; Ramdani, 2012), can help learners achieve learning objectives (Nuangchalerm, 2014, p.69), and can increase learners' confidence in the ability of scientific (Brickman, 2009, p.1).

Inquiry learning is divided into 6 levels, that is level 0 to level 5 which provide a quantitative value and clearly show the role of students and teachers in the learning process (Sutman, 2008, p.38). The division of inquiry based on the level intended to enable students to learn the process of discovery, starting from the lowest level and then continues to the highest level based on the teacher's roles and student's roles. The higher the level of inquiry, the greater the role of students in learning, otherwise the lower the level of inquiry, the greater the teacher in learning.

Learning with the level of inquiry has stages: inquiry, methods, investigation, conclusions, and applications that the all of stage have different teacher's roles and student's roles according to their level of inquiry. This can be seen in Table 1 the level of inquiry instructional matrix.

Table 1 The level of Inquiry Instructional Matrix

Levels of Inquiry	**Pre-Laboratory Experience**		**Laboratory Experience**	**Post-Laboratory Experience**	
	Proposes Problem or issue to be explored	**Plant procedure to be used to explore**	**Carries out procedures, collects and analyzes data from observations**	**Supplies answers or conclusions related to the inquiry**	**Considers how the discoveries can be applied or can lead to other inquiries**
0	Teacher	Teacher	Teacher	Teacher	Teacher
1	Teacher	Teacher	Teacher	Teacher	Students
2	Teacher	Teacher	Teacher	Students	Students
3	Teacher	Teacher	Students	Students	Students
4	Teacher	Students	Students	Students	Students
5	Students	Student	Students	Students	Students

(Sutman, Schmuckler & Joyce, 2008, p.38)

Differences in the teacher's roles and student's roles in implementing inquiry-based learning activity level provide opportunities for students to be able to adjust the

knowledge and experience of science by learning to be followed. students will be able to follow the learning activities properly if the level of inquiry are applied in accordance with the student's capabilities. Research conducted Moyer (2012) shows that when the 7th grade students are given lessons at the level of inquiry that is higher than its ability, the quality of the entire work and the student's ability to complete the task decreased. Students more successful with teaching at the inquiry level 2 and inquiry level 3. Implementation of inquiry learning that is not in accordance with the level of students' abilities resulting in less successful learning objectives, This is as happened in Sayekti (2012) and Zhai, et.al. (2014) research which have received the results of that inquiry learning was not entirely successful in improving the cognitive learning outcomes and process skills.

The observations and interviews that have been conducted in SMA Negeri 1 Sleman found that teachers who teach physics has been implementing inquiry learning in the learning process. The teacher said that the inquiry learning is often done inquiry learning of level 2 (ILL-2). However, there are students who are not interested in the learning process ongoing. The Exam Results which was held at SMAN 1 Sleman for subjects Physics class X has not reached the minimum completeness criteria. , This indicates that students have not been able to follow the inquiry learning correctly. Teachers need to understand that the inquiry learning has several levels that are tailored to the level of understanding of students and the need to examine how teachers teach inquiry so that the inquiry learning can work well and cognitive student learning outcomes can be improved.

Cognitive learning outcomes is a description of the ability to apply the concepts to be able to solve problems in everyday. This capability is often referred to as the ability to use knowledge in a variety of situations in context (Subali, 2012, p.33). Dimensions of cognitive processes revised consists of six aspects: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) (Anderson & Krathwohl, 2001, pp.67-68).

Student's process skills of in high school N-1 Sleman also not been assessed specifically by teachers. In fact science process skills is central to the acquisition of scientific knowledge useful in problems solving in society (Abungu, 2014, p.359). Science process skills is the ability of students to implementation scientific methods to understand, develop and discover science (Semiawan, 1989, p.17; Akinbobola & Afolabi, 2010, p.234; Dorish, 1998, p.52). Process Skills can support of students' thinking, reasoning, investigation, evaluation, and problem solving skills and creativity (Özgelen, 2012, p.291), as supporters of other cognitive skills such as logical thinking, reasoning and problem

solving skills (Abd Rauf, 2013, p.54), process skills essential for meaningful learning (Karamustafaoğlu 2011, p.33). Process skills help students so that they can feel the direct experience with objects and events around them (Osman, 2012, p.6). Process skills is important for students to gain knowledge based on the scientific process. Therefore, during the learning of physics, process skills need to be assessed by the teacher, so students and teachers can customize the learning and then gradually increase the ability of students to a higher level.

Teacher's Knowledge on the level of inquiry which is owned by the students very important , so that physics learning should be taught to implementation of inquiry learning will not be a problem anymore. Students can be familiarized with the inquiry learning in stages based on the level, not directly given inquiry learning at the highest level which usually gives failures in the process. Inquiry learning has several levels, so that teachers can build a scientific investigation with different levels of guidance so that every student has the opportunity to choose the level that suits their learning style (Llewellyn, 2011, p.29). This study will use several levels of inquiry on the students to see which is more in line with their ability to improve cognitive learning outcomes and process skills.

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RESEARCH METHOD

The research involved quasi experimental research using the pretest-posttest non-equivalent control group design (Wiersma,1986, p.169). The design used is given in Table 2.

Table 2

Research Design

Groups	Pre-test	Treatment	Post-test
Control		X_1	
Experiment 1	O_1	X_2	O_2
Experiment 2		X_3	

The population comprised year X students of SMA Negeri 1 Sleman in their second semester of the academic year of 2014/ 2015. A sample of three classes was established using the cluster random sampling technique. The three classes were assigned as an experimental class 1, experimental class 2, and control class. While the students of the experimental class 1 were taught using the inquiry learning of level 3 (ILL-3), the students of experimental class 2 were taught using the inquiry learning of level 4 (ILL-4) and the students of the control class were taught using inquiry learning of level 2 (ILL-2).

The data were collected through observation and testing. The multiple choice test was used to know the cognitive learning outcome of the students in the lesson about static fluid before and after the treatment. The test include 20 item. The reliability coefficient was estimated 0,75. The essay test was used to know process skills of the students in the lesson about static fluid before and after the treatment. The test include 6 item. The reliability coefficient was estimated 0,72.The aspects of process skills were making observations, formulating hypotheses, interpreting the data, drawing conclusions, and communicating. Data obtained via the instruments mentioned above were analysed with SPSS 20.0. The Mean and gain of test scores were calculated. it was observed that the scores are distributed normal and homogeneous. Furthermore, MANOVA (Multivariate Analysis of Variance*)* test used to determine significant differences between the results gain of ILL-2, ILL-3 and ILL-4. The gain is obtained using the equation:

$$g = \frac{s_{post} - s_{pre}}{s_{maks} - s_{pre}}$$

g is the gain normalized scores, s_{post} is posttest scores, s_{pre} is pretest scores. Criteria of gain can be seen in Table 2.

Table 2. Criteria of gain

Gain	Criteria
$g > 0.7$	High
$0.3 \leq g \geq 0.7$	Middle
$g < 0.3$	Low

(Hake, 1998, p.65)

After finding out that there are differences in effectiveness ILL-2, ILL-3 and ILL-4 in improving cognitive learning outcomes and process skills, The next is to conduct post hoc

test. Post hoc test is used to find out more detail about the different groups significantly and groups did not differ significantly at each pair multivariate.

RESULT AND DISCUSSION

Result

Picture 1 and Picture 2 shows pretest and posttest mean scores for experimental group 1 (ILL-3) , experimental group 2 (ILL-4) and control group (ILL-2).

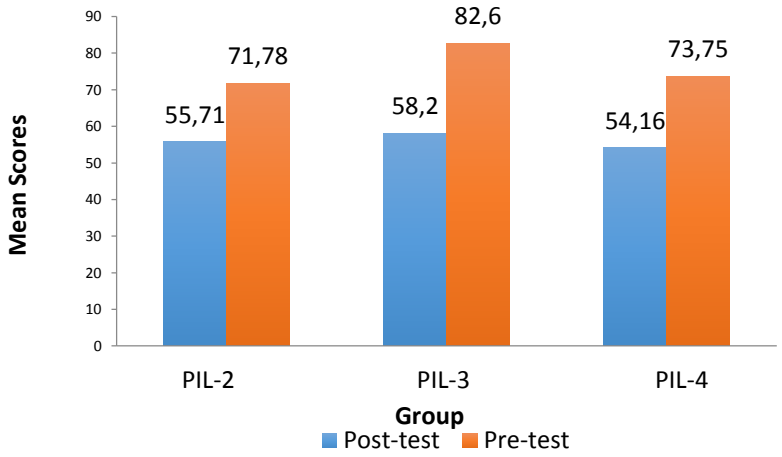

Figure 1. Comparison mean scores of pretest and posttest of cognitif learning outcomes

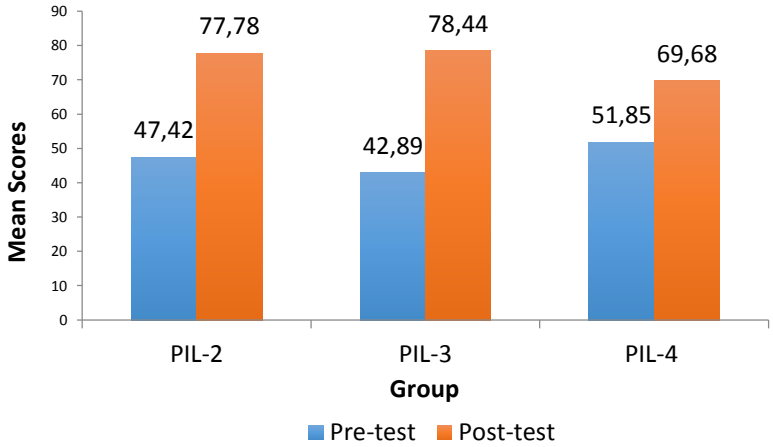

Figure 2. Comparison mean scores of pretest and posttest of process skills

Figure 1 shows an increase in cognitive learning outcomes after given ILL-2, ILL-3, and ILL-4. This indicates that the inquiry learning is effective in improving the cognitive learning outcome, although the mean scores pretest and posttest cognitive learning outcomes ILL-3 higher than ILL-2 and ILL-4. The results are consistent with the results of research conducted by Saputra et al. (2012, p.44) and Yunus et.al (2012, p.48) which has stated that the inquiry learning can improve student learning outcomes.

Figure 2 shows an increase in process skills after given ILL-2, ILL-3, and ILL-4. This indicates that the inquiry learning is effective in improving the process skills, although the mean scores pretest and posttest process skills ILL-3 higher than ILL-2 and ILL-4.

Research conducted Blessing (2014, p.51) showed that inquiry effective to cultivate student's process skills. This is because in the process of inquiry learning emphasis on meaningful learning, in which students actively participate in learning activities and can do scientific activity in defining the concept being studied.

Table 3. The gain calculation result

ILL-2 *N-Gain*		ILL-3 *N-Gain*		ILL-4 *N-Gain*	
Cognitive	PS	Cognitive	PS	Cognitive	PS
0,34	0,58	0,57	0,62	0,41	0,35

Table 4. Multiple of Variance (MANOVA) of gain scores

Effect	F	sig.	Description
Wilks' Lambda	26,36	0,00	There was difference significant

Table 3 shows that the gain of the cognitive learning outcome ILL-3 (0.57) is greater than the gain ILL-4 (0.41) and gain ILL-4 (0.41) is greater than the gain ILL-2 (0.34). The gain of the process skills ILL-3 (0.62) is greater than the gain ILL-2 (0.58) and gain ILL-2 (0.58) is greater than the gain ILL-4 (0.345).

Table 4 shows that the significance value obtained from MANOVA test was 0.00 and worth less than $\alpha = 0.05$ thus obtained a decision that Ho is rejected, it can be concluded that there are significant differences in effectiveness between inquiry learning of level 2 (ILL-2), inquiry learning of level 3 (ILL-3), and inquiry learning of level 4 (ILL-4).

MANOVA test analysis showed that there were significant differences in effectiveness between ILL-2, ILL-3, and ILL-4 ($p < 0.05$) in improving cognitive learning outcomes and process skills. Since there was significant difference between the means of the group, it was necessary to carry out post-hoc comparisons test of gain mean to establish where the differences occured. The test were carried out using Tukey HSD procedure at $p<0,05$ level.

Table 5. Post-Hoc Comparison of the Gain Means for the three Groups

Dependent variable	**(I) Inquiry Level**	**(J) Inquiry Level**	**Mean Difference (I-J)**	**Sig.**
Cognitive	2	3	-0,2259*	0,000
Learning		4	-0,0644	0,441

Outcomes	3	2	0,2259*	0,000
		4	0,1615*	0,010
	4	2	0,0644	0,441
		3	-0,1615*	0,010
Process Skills	2	3	-0,0397	0,697
		4	0,2248*	0,000
	3	2	0,0397	0,697
		4	0,2644*	0,000
	4	2	-0,2248*	0,000
		3	-0,2644*	0,000

Table 5 shows the results of the Tukey HSD Post-Hoc as follows: (1) there are significant differences between the ILL-2 and ILL-3 in improving the cognitive learning outcomes but there are no significant differences between the ILL-2 and ILL-3 in improving the process skills; (2) there were no significant differences between the ILL-2 and ILL-4 in improving cognitive learning outcomes, but there are significant differences between the ILL-2 and ILL-4 in improving the process skills, (3)) There are significant differences between ILL-3 and ILL-4 in improving the cognitive learning outcomes and process skills.

Discussion

The effectiveness of ILL-2, ILL-3, and ILL-4 on the cognitive learning outcomes and process skills of the students in class X SMA Negeri 1 Sleman, can be seen from the results of the descriptive analysis. The results showed that the mean of cognitive learning outcomes and process skills increased after given ILL-2, ILL-3 and ILL-4. It is consistent with the results of research conducted by Saputra et al. (2012, p. 44), and Yunus et al. (2012, p.48) which has stated that the inquiry learning can improve student learning outcomes. In addition, Blessing (2014, p. 51) suggests that inquiry effective to fosters process skills of students. This is because in the process of inquiry learning emphasis on meaningful learning, in which students actively participate in learning activities and can do scientific activity in defining the concept being studied.

Students in inquiry learning through direct experience, they ask questions and find answers to their own questions of the data / facts. It is as expressed by Fang (2010, p. 3) which has stated that through inquiry learners learn to use scientific knowledge, processes, thinking and reasoning skills that are important in making and discuss their questions. This is why the knowledge of students which followed the inquiry learning will be durable and hard to forget. In addition, through the stages of inquiry learning, students become trained in doing scientific work so that students can improve process skills.

Differences in effectiveness that occurred on ILL-2, ILL-3, and ILL-4 on hypothesis testing occurs due to the different roles of teachers and students during the learning process, as described below: First, there are significant differences between the ILL-2 and ILL-3 in improving cognitive learning outcomes but there are no significant differences between the ILL-2 and ILL-3 in improving the process skills. In the ILL-3, students are directed to begin an independent in performing activities without a demonstration of teachers as in the ILL-2, so that students are more active in constructing their knowledge with their own thoughts.

Second, there are no significant differences between the ILL-2 and ILL-4 in improving cognitive learning outcomes, but there are significant differences between the ILL-2 and ILL-4 in improving the process skills. In the ILL-4, students have not been able to follow the learning well, because in the ILL-4 students are required to be independent in carrying out activities to create independent investigation procedures with the teacher's role slightly. Students are still not accustomed to entering the inquiry level higher than the level of inquiry that they typically have done.

Third, there are significant differences between the ILL-3 and ILL-4 in improving cognitive learning outcomes and process skills. In the ILL-3 and ILL-4 students have begun accustomed to independent in conducting investigations. It makes students have meaningful learning, but students in the ILL-4 are required to be more independent than ILL-3. Students can not follow the learning ILL-4, because the good inquiry learning can only be given to students in sequence starting from the lowest level to the highest level, during this learning students still switch from the ILL-2 to the ILL-3.

CONCLUSION AND SUGGESTION

Conclusion

From the result and discussion, it can be concluded that: *First*, there are significant differences in effectiveness among inquiry learnings of level 2 (ILL-2), level 3 (ILL-3), and level 4 (ILL-4) on the cognitive learning outcomes and the process skills of year X students of SMA Negeri 1 Sleman. Second, Learning inquiry of level 3 (ILL-3) is more effective than inquiry learning of level 2 (ILL-2) and inquiry learning of level 4 (ILL-4) in improving the cognitive learning outcome and process skills seen from the value of the gain.

Suggestion

Based of finding obtained, suggestion that can be given are: *First*, teachers can implementation inquiry learning at a level appropriate to their ability and level of experience of the students of science in improving the cognitive learning outcomes and

process skills for later upgraded to the next level. Second, to other researchers to expand the material and the variables used in the study, including covariates variables have an influence on the results of research.

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