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The Implementation of Project-based Learning and Guided Inquiry to Improve Science Process Skills and Student Cognitive Learning Outcomes

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ABSTRACT

The aim of this research is to analyze the student's science process skills and cognitive learning outcomes in implementing project-based learning and guided inquiry. The design used is quasi-experimental design. Sampling technique is matching pretest-posttest comparison group design. Data are analyzed using t-test and N-Gain. The result shows that it is statically differences between project-based learning and guided inquiry toward students' science process skills (sig. 0.022 < 0.05) and cognitive learning outcomes (sig. 0.013 < 0.05). Project-based learning is more effective than a guided inquiry to increase the student's science process skills and cognitive learning outcomes. Based on this research result, the teacher should be implemented the project-based learning to improve student's science process skills and cognitive learning outcomes.

Keywords: project-based learning, guided inquiry, science process skills, cognitive learning outcomes

INTRODUCTION

The current changes in the national education system in Indonesia are based on competencies that must be mastered by students in the 21st century. These demands are like those of students who compete with information technology and high-level thinking technology literacy. To achieve this, the learning should be done through scientific learning in the laboratory either through real experiments or virtual experiments. Science learning activities in the laboratory are the foundation of the learning model in the 21st century (Hofstein & Lunetta, 2004). To respond to this, the Indonesian government made a 2016 curriculum change into the 2013 curriculum. The 2013 curriculum demands the birth of a future generation that is productive, creative, innovative and characterized. With creativity, the children of the nation are able to innovate to answer the challenges of the future that are increasingly complicated and complicated (Mulyasa, 2014). Learning in the 2013 curriculum to improve competence and balance between attitudes, skills, and knowledge. To realize this, a learning plan is needed that only facilitates students to understand the material but also to hone the students' skills in learning. The 2013 curriculum orientation in Indonesia requires students to be more active, creative and innovative and emphasize learning through a scientific approach. Through scientific learning, it is hoped that it can grow science process skills and cognitive science.

Cognitive science is a network of interrelated scientific disciplines engaged in researching human cognition and its brain mechanisms (Marina, 2017). Cognitive science is known as cognitive learning outcomes in the 2013 curriculum. This domain is very important for students who include the ability to restate the concepts

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or principles that have been learned, which relate to the ability to think, competence gain knowledge, recognition, understanding, conceptualization, determination, and reasoning.

Science process skills have a very important role in training students to verify and construct physics concepts through a scientific approach. Science process skills are the development of physical and mental skills derived from the basic abilities that one possesses (Maikristina, 2013). In this process skill, students not only learn from the teacher, but also from their fellow friends and from other source humans. Therefore, process skills are one of the things that must be considered in order to facilitate the achievement of simultaneous learning goals on the aspects of effective, cognitive, and psychomotor. Science process skills in physics learning can be formed through scientific activities in learning that provide direct experience to students. The results of the study by Gormally, Brickman, Hallar, and Armstrong (2009) show that there is an increase in scientific literacy and research skills of students using laboratory instruction inquiry. The use of various teaching approaches in one lesson can create more opportunities for planting and acquiring science process skills in the classroom (Rauf, Rasul, Mansor, Othman, & Lyndon, 2013). To improve science process skills, not only through the had on activities strategy questions are also rather useful (Nikam, 2014).

The learning model that can involve students to carry out scientific activities in the learning process is project-based learning. The project-based learning model is a learning model that provides opportunities for teachers to manage classroom learning by involving project work (Wena, 2010). In addition, project-based learning is an instructional approach that offers the potential to help students develop flexible understanding and lifelong learning skills (Hmelo-Silver, 2004). The results of the study (Jagantara, 2014; Oktadifani, 2016) showed that student learning outcomes after learning using the project-based learning model were better than students who were taught with conventional models and improved science process skills of students in both categories of project-based learning models.

Another learning model that facilitates students to carry out scientific activities is the guided inquiry model. Inquiry teaching is effective and should be emphasized in schools (Kitot, Ahmad, & Seman, 2010). The guided inquiry learning model can fully involve all students' abilities to search and investigate systematically, critically, logically, analytically, so that students can formulate their findings confidently (Trianto, 2010). Student learning outcomes by implementing a guided inquiry learning model can practice science process skills and can improve student learning outcomes (Ajizah, Indrawati, & Harijanto, 2014; Ergül et al., 2013; Wahyudi, 2013). Physics of cognitive competence and science process skills of students using scientific learning inquiry models based on conceptual change was better than using conventional learning (Nasution, 2015).

Previous research has implemented a project-based learning model to look at the condition of science process skills and student learning outcomes compared to conventional learning models. Thus, the condition of the model compared is not balanced because the conventional model is not a scientific approach so it cannot facilitate students to carry out scientific activities. Likewise, research on applying the guided inquiry model to practice science process skills without any control class so that guided inquiry superiority cannot be compared with other learning models. Based on these conditions, researchers are interested in examining the comparison of science process skills and student learning outcomes in the project-based learning and guided inquiry learning model. The hope of this article is to contribute to teachers in terms of choosing the right learning model in improving student process skills and student cognitive learning outcomes.

METHOD

In this section, the design of the research, the population and the sample, the data collection tools, the collection of the data and the analysis of the data will be discussed.

Design of Research

This study used a quantitative approach. The independent variable of this study was the project-based learning model and guided inquiry learning model while the dependent variable was the science process skills and cognitive learning outcomes. This study involved two sample classes namely experimental class 1 and experimental class 2 which were given different treatments so that the design used was Quasi-Experimental Design with a Matching Pretest-Posttest Comparison Group Design model. In general, the design of this study can be shown in **Table 1**.

Table 1. Research Design

Group	Pretest	Dependent Variable	Posttest
E_1	O	X_1	O
E_2	O	X_2	O

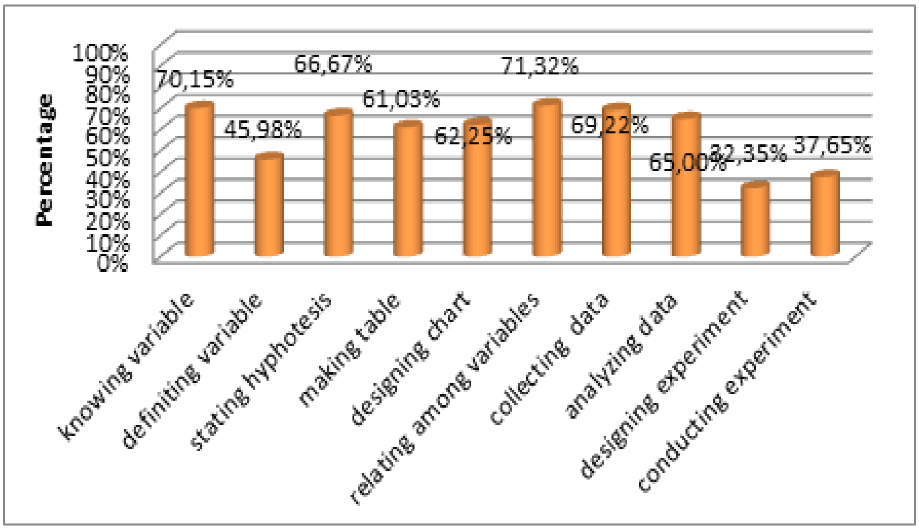

Figure 1. Result of analyzing the science process skills indicators on the project-based learning model

Sampling

The population in this study were all students of class X MAN City of Palangka Raya consisting of six classes. The selection of research class samples was conducted using a purposive sampling technique, namely sampling techniques with certain considerations (Sugiyono, 2009). The researcher took the sample class X IA-6 as the experimental class 1 which was taught using the project-based learning and X IA-4 learning model as the experimental class 2 which was taught using the guided inquiry learning model. The two sample classes are chosen because the class has almost the same initial conditions.

Data Collection Tool

The instrument used to collect data on science process skills and cognitive learning outcomes was a written test. To find out the validity of the items used the product moment correlation formula, the results of the validity analysis of 20 items about the test of science process skills test stated that 12 items were valid and 8 items were invalid. While cognitive learning results stated that 11 items were valid and 11 items were invalid.

Analysis of Data

Before hypothesis testing was carried out, a descriptive analysis of science process skills and cognitive learning outcomes was carried out in both the project-based learning and guided inquiry learning models. The hypothesis in this study was tested using the t-test through the SPSS program. Improved science process skills and cognitive learning outcomes in both the project-based learning and guided inquiry learning models were analyzed using N-gain.

FINDINGS

Science process skills from the ten indicators in the experimental class 1 given the treatment of the project-based learning model are presented in **Figure 1**.

Based on **Figure 1**, the score of students' science process skills in momentum material and impulses shows a varied percentage. The highest percentage of the average science process skills of students in the aspect illustrates the relationship between variables that is equal to 71.32%. The lowest percentage of the average science process skills of students in designing aspects of the experiment is 32.25%.

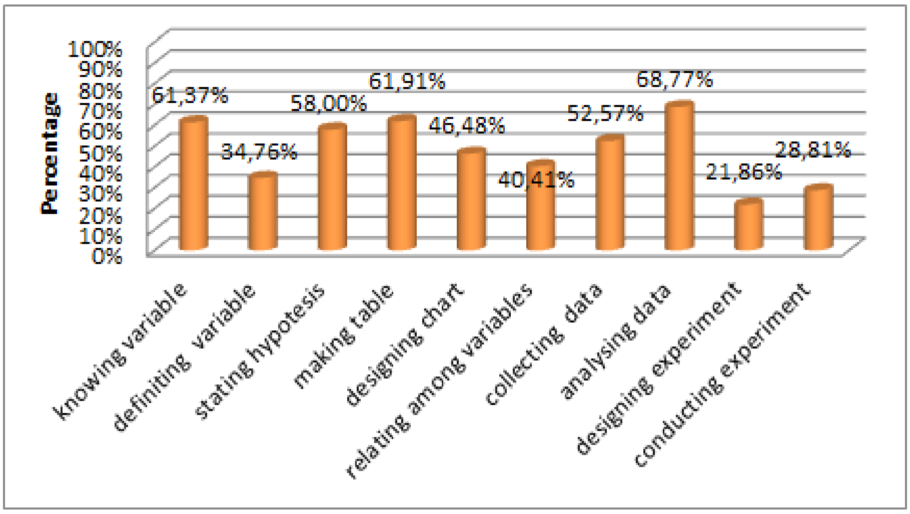

Figure 2. Result of analyzing the science process skills indicators on the guided inquiry learning model

Science process skills of students who were well categorized on the application of project-based learning models included (1) Identifying aspects of variables; Active students work on their own but still asked the teacher if they encountered difficulties in understanding variables, for example distinguishing between variables that affect the experimental results and the variables that result from the experiment. At the time of practicum, students were asked to vary the variables on the experiment so that students did not experience too much difficulty in answering questions about science process skills tests on indicators that recognize variables. (2) Aspects of composing hypotheses; Most students were able to predict and made conclusions temporarily before the practicum activities were carried out but there were still students who were less accustomed to making temporary conclusions. (3) Aspects of making data tables; Students were used to making tables of experimental results because they were often carried out by students when conducting previous practical activities so that students' ability to create data tables can be well trained. However, there were still students who were less skilled in making data tables, including not writing table titles, it was not appropriate to write the experimental data on the table. (4) Aspects of collecting and processing data; Active students work alone with the help of physics reference books but, there were still students who still found it difficult to collect and process data so that there were still many students who asked the teacher. (5) Aspects of analyzing experiments; Students work alone but still asked the teacher if they feel difficult. (6) The aspect of making graphics; Most students were able to graph the experimental results well but there were still students who were less skilled at making graphics. (7) Aspects of describing relationships between variables; Students learn to understand the variables and the relationship between independent variables and the dependent variable.

Science process skills of students who were in the medium category were in the aspect of identifying variables; Students found it difficult to describe the variables contained in the experiment so that it did not cause multiple interpretations. Students seldom identified variables during previous practical activities so that in the science process skills tests on indicators identifying variables students answer poorly.

Science process skills of students who were in the unfavorable category were (1) Aspects of designing experiments; The reason was the lack of active students in saw references related to the topic proposed. When practicum, students asked the teacher a lot about the experimental design but there were also students who were not serious in designing the experiment. (2) The aspect of experimenting; Most students still lack understood in experimenting. Students were still less active in conducting their own experiments on physics subjects so students still felt difficulties and asked questions with the teacher.

Science process skills from ten indicators in the experimental class 2 given the guided inquiry learning model are presented in **Figure 2**.

Based on **Figure 2**, the highest percentage of the average science process skills of students in the aspect of analyzing the experiment is 68.77% while the lowest percentage of the average science process skills of students in designing the experiment was 21.86%. Science process skills of students in the guided inquiry learning model that was in the good category included (1) Aspects of recognizing variables; Students could

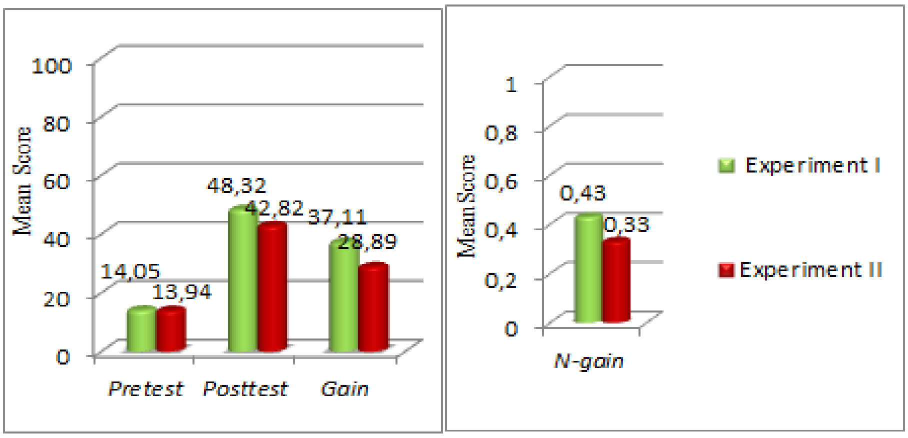

Figure 3. Statistic descriptive of science process skills

Table 2. Results of hypothesis testing on science process skills

No	Science process skills	Sig*	Notes
1	*Pretest*	0.959	No statistically significant differences
2	*Posttest*	0.004	Significant differences
3	*Gain*	0.022	Significant differences

*Level of Significance 0.05

work alone and observe things that were cause and effect in the experiment when the practical activities took place. (2) Aspects of making tables; Students made a table of experimental data without asked many questions to the teacher as seen at the time of the practicum but there were still many students who made incomplete data tables. (3) Analyzing aspects; When practicing, students were able to recognize variables and vary them. Students were also able to understand the causes found in the experiments conducted.

Science process skills of students who were in the medium category were (1) Aspects of composing hypotheses; Before carried out the experiment, especially the students arranged hypotheses, some students could formulate hypotheses well but there were still some other students who still found it difficult to formulate hypotheses properly. (2) Aspects of collecting and processing data; some students still found it difficult to collect and process data so there were still many students who asked the teacher. (3) Graphical aspects; Some students were still not able to graph well and neatly because students were not used to making graphs of experimental results. While the science process skills of poorly categorized students were (1) Aspects of describing relationships between variables; Some students were still not able to describe the relationship between variables properly. When practicum activities took place, some students asked a lot and found it difficult when describing the relationship between the variables. (2) Aspects identify variables; During practicum activities, many students were only able to recognize variables both independent and bound variables but have not been able to provide a limit on the variable itself. (3) Aspects of designing experiments; guided inquiry learning model that required students to be active in investigating their own experiments so students found difficulties in designing experiments. (4) Experimental aspects; The low score of science process skills on aspects of experimentation was due to students still not accustomed to experimenting on their own subject topics that have been determined, many students asked the teacher and many encountered difficulties when the experiment activities took place.

The average pre-test and post-test values for science process skills of students in the experimental class 1 and experimental class 2 are shown in **Figure 3**.

The results of hypothesis testing of the value of science process skills in the subject matter of momentum and impulse can be seen in **Table 2**.

The school policy of MAN City of Palangka Raya that students were said to be complete if their individual learning outcomes are ≥ 75%. The results of individual completeness analysis using the project-based learning model in the subject matter of momentum and impulses of 26% were complete and 74% were not completed. While the guided inquiry model was 15% complete and 88% was not complete.

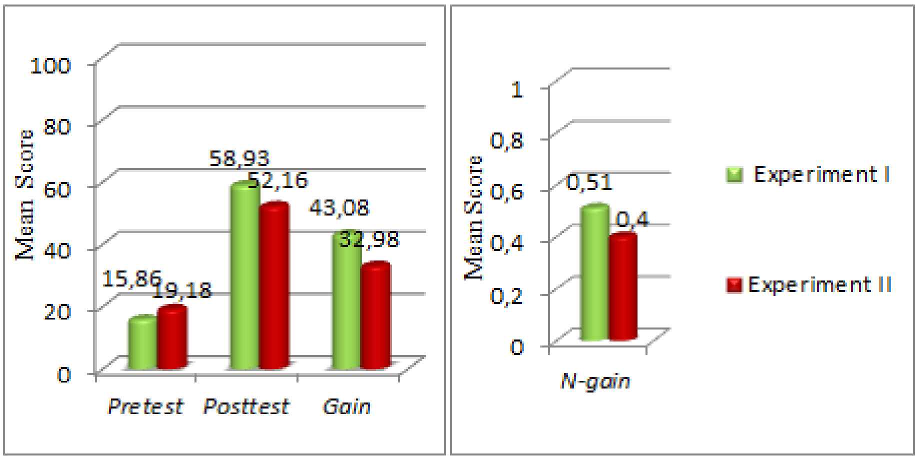

Figure 4. Statistic descriptive of cognitive learning outcome

Table 3. Results of hypothesis testing on cognitive learning outcome

No	Cognitive Learning Outcome	Sig*	Notes
1	*Pretest*	0.140	No statistically significant differences
2	*Posttest*	0.024	Significant differences
4	*Gain*	0.013	Significant differences

*Level of Significance 0.05

The incompleteness of students' cognitive learning outcomes was caused by several factors, including during the learning process, the teacher was less than optimal in designing the learning process so that not a few students become less familiar with the teacher's intent and purpose. In addition, the project-based learning model required students to create projects related to the subject of momentum and impulses so that there were still many students who were only focused on the project without noticing and learning the concepts of momentum and impulses.

The number of students who were not incomplete was caused by several factors, namely, during the learning process, the teacher was less than optimal in directing students to conduct their own experiments. Teachers were also not optimal in providing tools and materials so that some groups become less than optimal in conducting their own experiments. In addition, the guided inquiry learning model requires students to self-examine experimental topics that were in accordance with the subject of momentum and impulses. Students were accustomed to listening to teacher explanations so that when carried out their own investigations many students encountered difficulties. The lack of enthusiasm and interest of students in finding references makes students' cognitive abilities to be low.

The average value of the pretest and posttest for experimental class 1 cognitive learning outcomes and experimental class 2 is shown in **Figure 4**.

The results of the hypothesis testing of cognitive learning outcomes in the subject matter of momentum and impulses can be seen in **Table 3**.

The average cognitive learning outcomes of the experimental class 1 pretest were 15.86 and experiment class 2 was 19.18. The average pretest of the two classes has a difference of 3.32 so that it can be said that the two groups have the same ability before being given treatment. This was evidenced by the analysis of different test pretest cognitive learning outcomes given to the two experimental classes which showed that there were no significant differences between the values of the pretest tests of cognitive learning outcomes of the two classes as shown in **Table 2**. After being given different treatments, both classes The experiment was given a posttest of cognitive learning outcomes, the average value of the experimental class 1 posttest was 58.93 and the experimental class 2 was 52.16. Both of these values have a difference of quite large, namely 6.77 so that it can be said that the two classes have different abilities after being treated. This was confirmed by the results of the posttest trial analysis, the cognitive learning outcomes of the experimental class 1 and experimental class 2 showed that there were significant differences between the posttest values of the cognitive learning outcomes of the experimental class 1 and experimental class 2. This could be due to the project-based learning model and the guided inquiry has different characteristics even though the two models both require active and independent students in the learning process.

DISCUSSION AND CONCLUSION

The results of the analysis of N-gain science process skills in the project-based learning model were obtained at 0.43 with the medium category. The increase in the average value of the experimental class is caused by the project-based learning model requires students to be involved in a project related to the material that has been determined. Students understand their own concepts and knowledge and put the knowledge they have into the products they will make. This is supported by research by Utari et al. (2016) which says that a series of learning activities with the project-based learning model strongly encourages students to be active and skilled in learning activities with students understanding their own knowledge through designing project designs and in implementing students can build knowledge through experience experimenting with real groups.

The project-based learning model can improve students' science process skills by showing an N-gain value of 0.43. Students become active, creative and skilled in collaborating to produce quality products. The science process skills in this study are not maximal because of several factors encountered by researchers when using project-based learning during the learning process, among others, some students play games and are not serious in project work so that only a few students in the group are serious and ask the teacher and their limited lesson hours in each meeting cause students to be not optimal in working on the project.

The results of the analysis obtained N-gain value of science process skills in the guided inquiry learning model obtained at 0.33 with the medium category. The increase in the average value of the experimental class is caused by the guided inquiry learning model involves the activities of students in honing their process skills. This is in line with Wiwin Ambarsari (2013, p. 89) which states that students' inquiry approaches do more activities in learning than conventional approaches and are able to improve basic science process skills.

The guided inquiry learning model can improve students' science process skills. Students become active in designing experiments and discovering their own knowledge. In this study, science process skills have not been maximized because of some obstacles encountered by researchers when using guided inquiry during the learning process. The first obstacle is that some students play around and are not serious about the project so that only a few students are in a serious group and ask the teacher. The second obstacle, the limited learning hours in each meeting caused the guided inquiry learning process to be not optimal.

The project-based learning and guided inquiry learning models have their respective advantages in facilitating the development of students' science process skills. The superiority of the project-based learning model is that it can provide opportunities for students to create their own works based on the knowledge they have. Project creation is able to provide experience directly to students so students can construct knowledge (Fatimah, 2016). Thus, students' process skills can be well honed. Meanwhile, the superiority of the guided inquiry learning model is that it can facilitate students to gain the ability to use laboratory instruments, obtain broad and more in-depth information that can be applied in life (Kuhlthau, Leslie, & Ann, 2007). The guided inquiry learning model makes students more active and independent. Students are given the freedom to design their own investigations. The science process skills in the guided inquiry learning model are lower than the project-based learning models. This is indicated by the results of this study that the achievement of process indicators in good categories is 70% in the temporary project-based learning model of only 30% in the guided inquiry learning model.

N-gain of cognitive learning outcomes of students in the project-based learning model was obtained at 0.51 with the medium category. Increased cognitive learning outcomes due to project-based learning models are active learning that is developed based on the concept of constructivism. Students plan their own ideas and ideas, explore their own knowledge through books or other references and pour into projects that are done to produce quality products. The project-based learning model encourages students to share and communicate with each other, cooperate and find knowledge from real experience. This is reinforced by Yance (2013) who said that the increase in student physics learning outcomes in the cognitive domain caused project-based learning not only to provide knowledge about the concept of physics but also to make knowledge meaningful through project activities that transform abstract concepts into reality, so that the concept lasts long in the minds of students. This is also in line with Nurohman (2007) in his article who said that project-based learning is a learning approach that gives freedom to students to plan learning activities, implement projects collaboratively, and ultimately produce work products that can be presented to others.

N-gain learning outcomes in the guided inquiry learning model were obtained at 0.40 with a moderate category, which meant there was an increase in the students' pretest and posttest scores. The cognitive abilities of students in experiment class 2 experienced an increase before and after being given treatment using the guided inquiry learning model. Students are given a problem to find a solution to the learning process. Students make hypotheses and prove them by designing and carrying out their own experiments so that students can collect experimental data and draw conclusions by linking their experimental results to theories that already exist in books or other references. This is in line with the opinion of Santiasih (2013) who said that the guided inquiry or guided inquiry model is based on discovery learning theory where students actively construct their knowledge based on the stages of the guided inquiry learning model. This learning model encourages students to explore their own knowledge and provide real experiences in life or around students. This is also supported by Maikristina (2013) who said that the guided inquiry learning model provides an opportunity for students to be active in learning and gain experience in finding concepts for themselves.

The project-based learning model can be seen as a learning model that focuses on the core concepts and principles of a discipline, facilitating students to be actively involved in investigating, solving real-world problems, other meaningful tasks, and producing a real product with the aim of increasing motivation. high-level thinking skills, understanding the material as a whole and improving student process skills (Jagantara, 2014). Through this learning model, it can facilitate students to develop high-level thinking skills that have implications for science process skills and student cognitive learning outcomes. Roth and Roychoudhury (1993) showed that students develop higher-order process skills through traditional laboratory experiences that provide students with the freedom to perform experiments of personal relevance in authentic contexts. Learning like this can be achieved through project-based learning. However, actively engaging students in project-based or collaborative activities can encourage students 'critical thinking development if instructors model the thinking process, use effective questioning techniques, and guide students' critical thinking processes. (Snyder & Snyder, 2008). The guided inquiry learning model helps students build knowledge and skills, ask questions and look for answers based on their interest and curiosity (Suyanto, 2013). Also, guided inquiry increased the content knowledge of students and the development of process skills of observation, questioning and communicating (Strom, 2012). Both of these learning models involve students in their learning activities. The difference between the two models lies in the planning. Planning on the project-based learning model is carried out by students in the form of tools and materials, implementation schedule and tool construction while the planning of the guided inquiry learning model is carried out by students in the form of work designs and steps.

Based on the results of data analysis and discussion it can be concluded that (1) There are significant differences in science process skills between students taught with project-based learning models and students taught with the guided inquiry model. The achievement of process skills indicators in the project-based learning model is better than the guided inquiry learning model. (2) There are significant differences in cognitive learning outcomes between students taught with project-based learning models and students taught with the guided inquiry model. Learning completeness in the project-based learning model is more than the guided inquiry learning model. (3) Improving science process skills and student learning outcomes in the project-based learning model and the inquiry learning model are in the medium category.

Disclosure statement

The author states that there is no potential conflict of interest in writing this article.

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REFERENCES

Ajizah, N., Indrawati, & Harijanto, A. (2014). Penerapan Model Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Proses Sains Dan Hasilbelajar Fisika Siswa Kelas Xc Di Man 2 Jember Tahun Ajaran 2013/2014. *Jurnal Pendidikan Fisika*, *3*(3). Retrieved from http://fisika.fkip.unej.ac.id

Ergül, R., Şimşekli, Y., Çaliş, S., Özdilek, Z., Göçmençelebi, Ş., & Şanli, M. (2011). The effects of inquiry-based science teaching on elementary school students' science process skills and science attitudes. *Bulgarian Journal of Science & Education Policy*, *5*(1). Retrieved from http://bjsep.org

Fatimah, S. (2016). Pengaruh Pembelajaran IPA Menggunakan Project Based Learning (PJBL) Dan Seven Jumps Terhadap Keterampilan Proses Dan Karakter Sains Peserta Didik Pada Materi Peristiwa Alam. *Jurnal Pendidikan Universitas Sebelas Maret*, Retrieved from http://www.jurnal.fkip.uns.ac.id

Gormally, C., Brickman, P., Hallar, B., & Armstrong, N. (2009). Effects of inquiry-based learning on students' science literacy skills and confidence. *International journal for the scholarship of teaching and learning*, *3*(2), 16. https://doi.org/10.20429/ijsotl.2009.030216

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational psychology review*, *16*(3), 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science education*, *88*(1), 28-54. https://doi.org/10.1002/sce.10106

Jagantara, I. M. W. (2014). Pengaruh Model Pembelajaran Berbasis Proyek (*Project Based Learning*) Terhadap Hasil Belajar Biologi Ditinjau dari Gaya Belajar Siswa SMA. *Jurnal penelitian Pascasarjana Undiksha, 4*(1). Retrieved from http://pasca.undiksha.ac.id

Kitot, A. K. A., Ahmad, A. R., & Seman, A. A. (2010). The effectiveness of inquiry teaching in enhancing students' critical thinking. *Procedia-Social and Behavioral Sciences, 7*, 264-273. https://doi.org/10.1016/j.sbspro.2010.10.037

Maikristina, N. (2013). Pengaruh Penggunaan Model Pembelajaran Inkuiri Terbimbing Terhadap Hasil Belajar Dan Keterampilan Proses Sains Siswa Kelas XI IPA SMAN 3 Malang Pada Materi Hidrolisis Garam. *(Online), 2*(2). https://doi.org/10.22611/jpf.v3i1.3277

Marina, B. (2017). Cognitive science: from multidisciplinarity to interdisciplinarity. *International Journal of Cognitive Research in Science, Engineering and Education*, *5*(2). https://doi.org/10.5937/ijcrsee1702145B

Mulyasa. (2014). *Pengembangan Dan Implementasi Kurikulum 2013*. Bandung: Remaja Rosdakarya.

Nikam, M. P. (2014). *Using Questioning Strategy to Enhance Scientific Process Skills*. Retrieved from http://researchgate.net

Oktadifani, U. (2016). Pengaruh Model Project Based Learning Terhadap Keterampilan Proses Sains Dan Hasil Belajar Siswa Dalam Pembelajaran Fisika Di SMA. *Jurnal Pembelajaran Fisika*, (online), *5*(2). Retrieved from https://jurnal.unej.ac.id

Rauf, R. A. A., Rasul, M. S., Mansor, A. N., Othman, Z., & Lyndon, N. (2013). Inculcation of science process skills in a science classroom. *Asian Social Science*, *9*(8), 47-57. https://doi.org/10.5539/ass.v9n8p47

Roth, W. M., & Roychoudhury, A. (1993). The development of science process skills in authentic contexts. *Journal of Research in Science Teaching*, *30*(2), 127-152. https://doi.org/10.1002/tea.3660300203

Santiasih, N. L. (2013). Pengaruh Model Pembelajaran Inkuiri Terbimbing Terhadap Sikap Ilmiah Dan Hasil Belajar Ipa Siswa Kelas V SD No. 1 Kerobokan Kecamatan Kuta Utara Kabupaten Badung Tahun Pelajaran 2013/2014. *Jurnal penelitian Pascasarjana Undiksha, 3*(1). Retrieved from http://pasca.undiksha.ac.id

Snyder, L. G., & Snyder, M. J. (2008). Teaching critical thinking and problem solving skills. *The Journal of Research in Business Education*, *50*(2), 90. Retrieved from https://tccl.arcc.albany.edu

Strom, R. (2012). *Using guided inquiry to improve process skills and content knowledge in primary science.* Retrieved from https://scholarworks.montana.edu

Sugiyono. (2009). *Metode Penelitian Pendidikan*. Bandung: Alfabeta.

Trianto. (2010). *Mendesain Model Pembelajaran Inovatif-Progresif: Konsep, Landasan, Dan Implementasinya Pada Kurikulum Satuan Pendidikan KTSP*. Jakarta: Kencana.

Wahyudi, L. E., & Supardi, I. (2013). Penerapan Model Pembelajaran Inkuiri Terbimbing Pada Pokok Bahasan Kalor Untuk Melatihkan Keterampilan Proses Sains Terhadap Hasil Belajar di SMAN 1 Sumenep. *Jurnal Inovasi Pendidikan Fisika,* (Online), 2(2), 62-65. Retrieved from http://www.e-jurnal.com

Wena, M. (2010). *Strategi Pembelajaran Inovatif Kontemporer Suatu Tinjauan Konseptual Operasional.* Jakarta: Bumi Aksara.

Yance & Rinta, D. (2013). Pengaruh Penerapan Model *Project Based Learning* (Pbl) Terhadap Hasil Belajar Fisika Siswa Kelas XI IPA SMA Negeri 1 Batipuh Kabupaten Tanah Datar. *Pillar of Physics Education.* (Online), 1(4), 48-54. Retrieved from http://ejournal.unp.ac.id