

Effectiveness of Problem-Based Learning and Discovery Learning to Cognitive Learning Results on Cell Subject of Senior High School Students

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Abstract: The learning process is strived to be able to improve cognitive learning outcomes. The cognitive learning outcomes of students of XIth class students majoring in natural sciences in city of Samarinda, are still low. Quasi-experimental studies have been conducted in XIth class majoring in natural science, odd semester of 2017/2018 academic year. The aim of the research is to determine the effect of implementation of Problem-Based Learning and Discovery Learning models on student's cognitive learning outcomes. The study sample is students of XIth class majoring in natural sciences in 1st public senior high schools. The sampling technique is purposive sampling. Instruments of study are test questions. The data were analyzed using ANCOVA. The data analysis result show that the sign value is 0.00; this means $0.00 < 0.05$ ($p < 0.05$). The conclusion is the implementation of learning models affect student's cognitive learning outcomes. Further studies are needed by enlarging the sample to obtain more information.

Key Words: problem-based learning; discovery learning; cognitive learning outcomes

Abstrak: Proses pembelajaran diupayakan untuk dapat meningkatkan hasil belajar kognitif. Hasil belajar kognitif siswa kelas XI jurusan ilmu pengetahuan alam di kota Samarinda masih rendah. Penelitian kuasi eksperimental ini telah dilaksanakan di kelas XI jurusan IPA semester ganjil tahun ajaran 2017/2018. Tujuan penelitian ini adalah untuk mengetahui pengaruh penerapan model Problem Based Learning dan Discovery Learning terhadap hasil belajar kognitif siswa. Sampel penelitian adalah siswa kelas XI jurusan IPA SMA Negeri 1. Teknik pengambilan sampel adalah purposive sampling. Instrumen penelitian adalah soal tes. Data penelitian dianalisis menggunakan ANCOVA. Hasil analisis data menunjukkan bahwa nilai signifikansi adalah sebesar 0,00; ini berarti $0,00 < 0,05$ ($p < 0,05$). Penelitian ini menyimpulkan bahwa penerapan model pembelajaran berpengaruh terhadap hasil belajar kognitif siswa. Diperlukan penelitian lebih lanjut dengan memperbesar sampel untuk mendapatkan informasi lebih lanjut.

Kata kunci: problem based learning; discovery learning; hasil belajar kognitif

INTRODUCTION

The learning process in class always implements certain patterns. Learning patterns are determined by the syntax of learning models applied in the classroom at that time. The application of certain learning models is intended to achieve certain learning goals. The learning models that are expected to be implemented according to the demands of the 2013 curriculum (K-13) are based on a scientific approach such as Problem-based Learning (PBL), and Discovery Learning (DL).

A learning that begins with a real problem is known as Problem-Based Learning (PBL) (Servant-Miklos, 2019), these scenarios embark not only understanding and synergizing authentic situations but amalgamating basic scientific principles (Dring, 2019). Learning that applies PBL has characters: begins with a problem; students formulate problems to guide them in solving these problems; learning based on student activities to understand and solve problems; integration various related fields of science; students apply knowledge, theories, methods, to reach new scientific con-

texts; group-based of students of learning (Andersen et al., 2019)

Discovery Learning (DL) is a problem solving model that will benefit students in dealing with their lives (Rosarina et al., 2016). The main characteristics of the discovery learning model are (1) student centered; (2) explore and solve problems to create, connect, and generalize knowledge; and (3) activities to combine new knowledge and existing knowledge (Cintia et al., 2018).

The combination of PBL + DL is a compound of PBL syntax and GL syntax. In the process of integrating the syntax of the two models, efforts are made to strengthen one another in an effort to improve student cognitive learning outcomes. Weak syntaxes on PBL are reinforced by the existing syntax on DL. And vice versa, the weak syntaxes in DL are strengthened by the syntaxes that exist in PBL.

Cells are the smallest structures of organisms. Cell size is microscopic. The pictures of cells are needed to observe the cells and the cell preparations using a microscope is needed to observe the cells in the laboratory. Cells of living things are very complex, containing thousands of components. To observe this, we experience limitations in carrying out experiments that can analyze complex components of cells (National Research Council, 2009).

Related to cognitive learning outcomes, Fiteriani and Baharudin (2017) explained that learning outcomes are the abilities of cognitive domains that children get after going through learning activities. Naimnule et al. (2016) emphasize that aspects of the concept in school and expressed in scores through test results.

The observation result (2016) in XIth class of students of the Natural Sciences Department, in 1st senior high school at city of Samarinda, showed that the cognitive learning outcomes of students in biology were still not maximal. Teachers often apply conventional learning, so students are generally passive in class. The research problem is whether there is an effect of implementing PBL and DL learning models on student cognitive learning outcomes?

The aim of this study is to determine the effect of the implementation of PBL and DL to students' cognitive learning outcomes. The problem solving plan is to conduct a quasi experiment in XIth class majoring in natural sciences, 1st senior high school at city of Samarinda, in the discussion of material about cells. Quasi-experimental implementation in odd semester of 2017/2018 learning year.

METHOD

This research type is a quasi experiment. The research design was nonequivalent pre test post test control group design. Studies that apply independent variables, namely PBL, DL, a combination of PBL+DL, and conventional learning; the dependent variable is student cognitive learning outcomes.

The population in this research were all of students in XIth class majoring in Mathematics and Natural Sciences in 1st senior high school at city of Samarinda. The sampling technique is purposive sampling. The inclusion criteria are: (1) the student is in XIth class majoring in Mathematics and Natural Sciences, (2) the student is continuously following the learning process during the application of the action according to each learning model in each group.

The study was conducted in XIth class of the majoring of Mathematics and Natural Science, odd semester, 2017/2018 academic year. The classes used in the study consist of four groups. The first group applied PBL, the second group applied DL models, the third group applied a combination of PBL+DL, and the fourth group applied conventional learning (control group). All experimental groups were in 1st senior high school at city of Samarinda; and statistically group equality tests have been conducted, using the biology grades of Xth class of students, even semester, 2016/2017 academic year.

The study instruments are questions test. Questions test are used to measure cognitive learning outcomes. Student cognitive learning outcomes are measured at the pre-test and post-test. The form and content of the questions in the pre test as same as uses in post test. The scoring rubrics are used for cognitive learning outcomes to correct the student work (Hard, 1994).

To determine the effectiveness of the implementation of learning models to cognitive learning outcomes using the pre-test and post-test. The data were analyzed using Analysis of Covariance (ANCOVA) ($p < 0.05$). If the ANCOVA results show a significant effect, then further tests are done using Least Significance Difference (LSD) posthoc test.

RESULTS

Before the treatment was applied, students in each treatment group were given a pre test. The purpose of the pre-test is to determine the condition of early cognitive learning outcomes of the four treatment groups.

Table 1, shows the average of pre-test scores of cognitive learning outcomes in the four treatment groups.

After applying the four treatments, students in the four treatment groups, given a post test. The score of students' cognitive learning outcomes in the post test showed that there was an increase for all learning models applied. Table 2 shows the average of post-test scores of students' cognitive learning outcomes.

Furthermore, to determine the effect of the learning model applied in study on cognitive learning outcomes, ANCOVA was conducted. ANACOVA results show that the implementation of learning models in study has an effect on cognitive learning outcomes ($p < 0.05$). Table 3 shows a summary of ANCOVA results.

Table 3 shows that the learning models application, influences the students' cognitive learning outcomes. However, it is important to know the effect of each level of learning models on cognitive learning outcomes. Therefore, it is necessary to proceed with LSD post hoc tests, to determine the effect of each level of the learning model on cognitive learning outcomes. Table 4, shows the results of LSD posthoc tests.

Table 1. Average Pre-test Scores of Students' Cognitive Learning Outcomes for Each Learning Model

No.	Learning models	Average score
1	<i>PBL</i>	35.5
2	<i>DL</i>	33.0
3	Combination of <i>PBL+DL</i>	23.8
4	Conventional	24.6

Table 2. Average Post-test Scores of Students' Cognitive Learning Outcomes for Each Learning Model

No.	Learning models	Average score
1	<i>PBL</i>	72.4
2	<i>DL</i>	78.6
3	Combination of <i>PBL+DL</i>	78.6
4	Conventional	68.5

Table 3. Summary of ANCOVA Results of Cognitive Learning Outcomes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2469.473 ^a	4	617.368	5.932	.000
Intercept	75813.571	1	75813.571	728.462	.000
Group*Pretest	2469.473	4	617.368	5.932	.000
Error	14049.919	135	104.073		
Total	785381.000	140			
Corrected Total	16519.393	139			

DISCUSSION

Learning Model versus Cognitive Learning Outcomes

Table 3, shows that there is an effect of the implementation of learning models on student cognitive learning outcomes. The results of the analysis mean that the syntaxes of each learning model provide a unique learning experience for students. Students can understand biological materials (about the cells), influenced by learning experiences through the application of each learning model.

The implementation of the syntaxes of certain learning models provides a unique experience for students. Therefore, the selection and application of certain learning models, need to be linked to the achievement of learning goals that will be achieved by students through classroom learning experiences. Fiteriani and Baharudin (2017) stated that learning science that is contextually designed will bring a positive atmosphere in the learning process of students. Such conditions will motivate students in expressing creative ideas, curiosity about something that is around him. Nur et al. (2008), Yamin (2013) added that the teacher can help students to learn information in such way that makes information so that information can be used as meaningful learning outcomes. Therefore, Yamin (2012) suggests that learners should provide and provide as many opportunities as possible for students to actively learn, create, develop, build, discuss, compare, collaborate, and conduct experiments. Nurtanto and Sofyan (2015)

Table 4. Results of LSD Posthoc Tests for Cognitive Learning Outcomes

Learning models	Notation
<i>PBL</i>	a
<i>DL</i>	a
Conventional	a
<i>PBL + DL</i>	b

states that Problem-Based Learning contributes to cognitive aspects. Mahanangingtyas (2017) adds that cognitive activity knowledge is a cognitive activity ability that can be channeled by someone who is learning.

Cognitive learning outcomes are student achievement after carrying out learning for the cognitive realm. The realm of cognitive learning outcomes, shows students mastery of concepts, analyzing the biological material discussed. Students will master the content of the lesson well if they have a learning experience that allows students to master the subject matter. Amisyah and Nurmaliah (2015) states that cognitive learning involves three processes, namely: (1) obtaining new information, (2) transforming information, (3) testing the relevance and knowledge of knowledge. The process of acquiring new information can be achieved if the student learning experience enables students to actively formulate problems, collect data; including new data or information for the student.

Average Cognitive Learning Outcomes for Each Learning Model

The results of the LSD post hoc test (Table 4), show that learning models: PBL, DL, and conventional, have the same effect on students' cognitive learning outcomes, and are equally higher than the combination of PBL + DL. The combination of PBL + DL gives the lowest cognitive learning score compared to other learning models.

The combination of PBL + DL is a combination of PBL syntax and DL syntax. There are two factors that can cause the combination of PBL + DL gives the lowest cognitive learning score compared to other learning models. The two factors are: (1) students are still not ready to carry out PBL + DL syntax, (2) questions for pre-test and post-test are classified as low-level cognitive according to the revised Bloom taxonomy. Thus, the teacher is familiar with PBL + DL syntax and applies it in class. Therefore, it is recommended that biology teachers more often apply the PBL + DL combination. In addition, the level of test questions to measure cognitive learning outcomes needs to be more evenly distributed for all cognitive levels (C1 through C6) according to the revised Bloom taxonomy). Nurfillaili and Anggereni (2016) reminded that in making questions teachers need to pay attention to the problem indicators. Thus, the teacher can know the distribution of cognitive levels that will be achieved by students.

Related to the average score of students' cognitive learning outcomes for the control class (conventional), giving the same score as PBL and DL. In fact, students in the control group are less active to find new information to complement their previous knowledge. As explained above, this condition can be caused by the contents of test questions to measure cognitive learning outcomes, still classified as low-level cognitive. Dikmenli and Cardak (2010) stated that the concept of learning is improvement and memorization, which is a surface approach. Learning according to a deep approach means understanding, interpreting reality, making generalizations for new conditions. Therefore, it is recommended that questions test applied to similar studies be strived to be evenly distributed at all cognitive levels according to revised Bloom's taxonomy.

CONCLUSION

Related to the analysis and discussion, it was concluded that the application of learning models (PBL, DL, combination of PBL+DL, and conventional) affect to student cognitive learning outcomes. In addition, PBL, DL, and conventional have the same cognitive value, and are equally higher than the acquisition of cognitive learning outcomes in the combination of PBL+DL. Related to conclusions, it is recommended for senior high school biology teachers, to prefer and apply learning models that more enable students in the learning process, in an effort to improve student cognitive learning outcomes in discussing material about "The cells".

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