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The 1st International Conference on Science, Mathematics, Environment and Education

To cite this article: 2018 *J. Phys.: Conf. Ser.* **1022** 011001

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Preface

Global framework of sustainable development proposed by UN has led to several in-depth scientific discussions focused on studies and reviews of the strategies and progress made so far. The main objective of the performed discussions is to examine the progress and seeking appropriate and more operational strategies addressing the challenge of better global sustainability achievements. In the discussion, university has an important position in providing solution from both, in result-chain area and in causal-chain area.

It cannot be denied that natural, environmental and education science play as a major backbone underpinning effort in seeking the solution of achieving the goal of sustainable development. Scholarly research, reviews and reports from these majors are of valuable scientific databases in achieving the goal of sustainable development. The spirit of having contribution in the aforementioned UN goal has led the UNS and the committee to organize this conference. This conference involving Science, Mathematics, Environment and Education in order to address the challenge of fulfilling holistic approaches towards the improvement of the quality of human life without ignoring the sustainability of the environmental system.

This first International Conference on Science, Mathematics, Environment and Education (ICoSMEE) aims at bringing together researchers, educators, scientists, and scholar students in the area of Science, Mathematics, Environment and Education to exchange and share their experiences, ideas, and findings and to discuss practical challenges encountered and the solutions to develop humanity and the quality of human life in a sustainable manner. The conference was held in Surakarta, Indonesia on September 16th, 2017. Hundred of mathematics and science education experts and practitioners joined the event. There were six keynote speakers who came from Indonesia, United Kingdom, Australia, and United State of America. Moreover, more than 200 articles were presented in the conference and 59 articles are selected to be publishing in the present conference proceeding.

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The influence of discovery learning model application to the higher order thinking skills student of Srijaya Negara Senior High School Palembang on the animal kingdom subject matter

To cite this article: F Riandari *et al* 2018 *J. Phys.: Conf. Ser.* **1022** 012055

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The influence of discovery learning model application to the higher order thinking skills student of Srijaya Negara Senior High School Palembang on the animal kingdom subject matter

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Abstract. This study aimed to find out the information in concerning the influence of discovery learning model application to the higher order thinking skills at the tenth grade students of Srijaya Negara senior high school Palembang on the animal kingdom subject matter. The research method used was pre-experimental with one-group pretest-posttest design. The research conducted at Srijaya Negara senior high school Palembang academic year 2016/2017. The population sample of this research was tenth grade students of natural science 2. Purposive sampling technique was applied in this research. Data was collected by (1) the written test, consist of pretest to determine the initial ability and posttest to determine higher order thinking skills of students after learning by using discovery learning models. (2) Questionnaire sheet, aimed to investigate the response of the students during the learning process by using discovery learning models. The t-test result indicated there was significant increase of higher order thinking skills students. Thus, it can be concluded that the application of discovery learning model had a significant effect and increased to higher order thinking skills students of Srijaya Negara senior high school Palembang on the animal kingdom subject matter.

1. Introduction

The 2013 Curriculum is applied in developing Indonesian education to improve the quality of students' potential to face the challenges of the future [1]. This expectation can be realized by changing the mindset of students through student centered learning and scientific approach to build students' creativity and critical thinking. Students are required to be able to think critically and creatively in solving a problem to develop the capacity of thinking. Critical and creative thinking processes of students included in the higher order thinking skills [2].

The ability to think critically is higher thinking processes. Ability to think is not just memorizing the facts, but it takes an understanding and mastering of students to connect knowledge and experience in solving the problem [3-5]. Higher order thinking skills of students can be seen from cognitive test result. Related with Graduates Competency Standards of the 2013 curriculum, the knowledge is gained through the remembering, understanding, applying, analysing, evaluating, and creating activities.



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These knowledge activities refer to Bloom's Taxonomy revision by Anderson & Krathwohl (2001) [6]. Higher order thinking skills is needed for students in preparation to solve the daily real life problems. Higher order thinking skills consist of the three top cognitive processes: analysing, evaluating, and creating [7-8].

Based on the observation and communication with biology teacher is known that higher order thinking skills of students are not optimally trained. The students are not accustomed to analyze issues so they think low level. This is indicated by the results of the pretest that 70% of students have a low level critical thinking category. Low level thinking skills include three cognitive processes: remembering, understanding, and applying. As a result, students can not apply their knowledge in the real because higher order thinking skills are not trained [5]. This is due to the implementation of learning model have not facilitated students to think higher level. Regarding to that problem, learning model required that students' facilitates to improve higher order thinking skills. In relation to this problem in the Curriculum of 2013 the Ministry of Education and Culture suggests some learning model that are Project Based Learning, Problem Based Learning and Discovery Learning.

The discovery learning model is a learning which students by actively engage finding their own concepts and principles analysing process to solve their problems, so they have learnt meaningfully [9-11]. This model has six stages, such as stimulation, problem statement, the data collection, the data processing, verification and generalization [12]. At the problem statement stage the students are emphasized to identify problems to this the students have to analyze problems solving. Furthermore, at the data collection stage and data processing, students work together in groups to gather information and process it to make hypotheses. Afterward, at the verification stage, the students prove the truth of their hypothesis. Then at the generalization stage, the students make conclusion. Thus with the model students are trained to identify problem by analysing, hypothesis making, hypothesis proving, and conclusion making. These activities are higher order thinking of cognitive process [13]. Related to this, discovery learning model has advantages in helping students to increase their cognitive processes skills, and problem solving ability [10]. After participating in the learning process by this model, the students are expected able to solve their daily real life problems with higher order thinking skills. Real life problems are the main study in biology. One of the studies in Biology is the animal kingdom. The real life problems associated with the animal kingdom such as elephantiasis, worm infections in cattle, tapeworms and hookworms as a parasite.

Based on the explanation above, this study tries to present how the effect of applying the discovery learning model to higher order thinking skills of the tenth grade Srijaya Negara senior high school Palembang students on the animal subject matter.

2. Methodology

Pre-experimental research was applied because this design is not yet a pain staking experimentation and persistence of external variables that take effect on the dependent variable [14]. The research design was one-group pretest-posttest design. This study used the measurement of initial tests before being treated and the measurement of the final test after being treated. The treatment in question of the study was the application of discovery learning model.

The study population was tenth grade students of natural science at Srijaya Negara senior high school Palembang academic year 2016/2017. The sample of this study was selected by using technique purposive sampling namely sampling technique with a certain consideration [14], in order to obtain tenth grade students of natural science 2 which includes 33 students as an experimental class.

The judgments made by researchers using the average value of the highest class as to help researchers determine the improvement in higher order thinking skills significantly by using discovery learning model.

Data collection techniques are written test form multiple-choice test with five possible answers are 20 questions that pertain to Bloom's taxonomy revision of cognitive levels to analyze, to evaluate, and to create. Higher order thinking skills of students was seen from the cognitive test result to use Bloom's Taxonomy revisions by Anderson & Krathwohl (2001). In addition, the researchers used a

questionnaire sheet directly response and closed by using a Linkert scale. Questionnaires were administered in this study is the student questionnaire responses in the form of statements to evaluate the response after being given the student learning by applying the discovery learning model. The student questionnaire responses contain of 19 statements with 15 positive and 4 negative statements.

The data analysis answer scores of initial tests and test scores end of each student each added together to determine the value of the initial test and final test the students with the following formula [15] :

$$\text{Value} = \frac{\text{score obtained}}{\text{score maximum}} \times 100$$

Furthermore, the test scores were grouped by ranges of values used with 80-99,9 criteria (excellent), 60-79,9 (good), 40-59,9 (enough), 20-39,9 (poor), and < 19,9 (very poor). The increase in higher order thinking skills of students after learning gain is calculated using the normalized values (n-gain). For the calculation of the normalized gain and level categories used formula of Hake [16], as follows:

$$\text{gain} = \text{value end-value tests initial tests}$$

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

Increased higher order thinking skills of students categorized gain index value which is divided into three categories of Hake [16], among others high ($g > 0.7$), moderate ($0.3 < g < 0.7$), and low ($g < 0.3$).

Then to calculate or analyze an average of data questionnaire has been responded by the students is done by changing each item in terms of percent later described. Test for normality using the assistance program SPSS 22 is by test Shapiro Wilk if the data are normally distributed then using statistical parametric and vice versa, if the data were not normally distributed then using statistical parametric [14]. After that, proceed with the hypothesis test is performed using sample t test to determine the significance of the increase in higher order thinking skills by discovery learning model.

3. Results and Discussion

Students are provided the pretest before the beginning of learning process at a meeting to determine the readiness and initial ability of students, then students are given posttest after the application of the learning process with the treatment discovery learning model is completed at the last meeting. Students have two types of test value, pretest value and posttest value. The percentage increase of higher order thinking skill on pretest and posttest are presented in Figure 1.

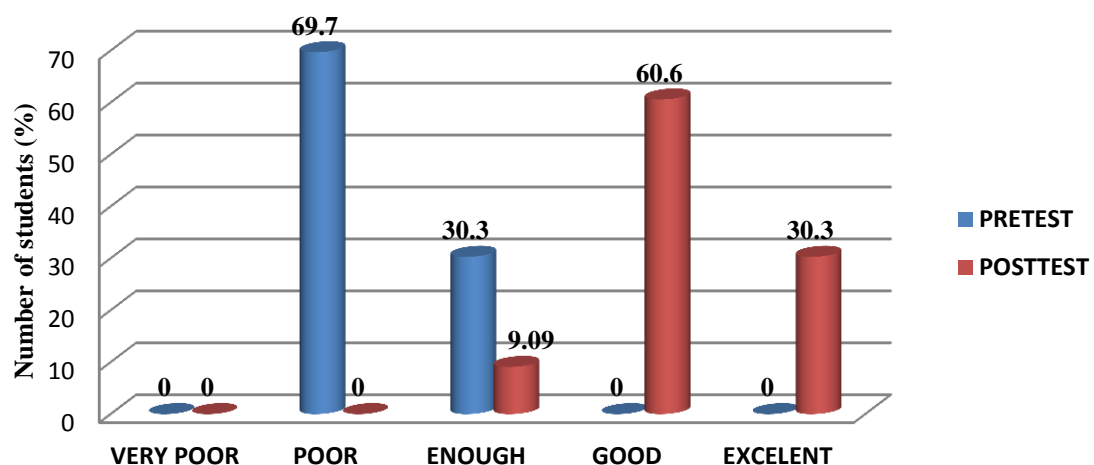


Figure 1. Number of Students (%) Based on The Category of Higher Order Thinking Skills

Based on the results on Figure 1, show that the percentage of pretest value in higher order thinking skills of student for “poor” and “enough” criteria as much 69.7% and 30.3%, while for “good” and “excellent” criteria is none. Then the percentage of posttest value in higher order thinking for “enough, very good, and excellent” criteria as much 9.09%, 60.6%, and 30.3%, while for “poor” is none. So, after discovery learning model was applied in learning, higher order thinking skills of student increased for “good” criteria from 0% to 60.6% and “excellent” criteria from 0% to 30.3%. Whereas, “poor” and “enough” criteria decreased from 69.7% to 0% and from 30.3% to 9.09%.

Higher order thinking skills of students can be seen through a different test mean value of pretest and posttest that should be normally distributed. However, due to the results of the initial test and final test is not normal, then the statistical analysis used is nonparametric statistics. Different test mean value of pretest and posttest using one sample t test with SPSS22. The number of students, the mean value of the pretest and posttest value, distribution, and significance are shown in Table 1.

Table 1. Normality Test and Mean Value Difference Between Pretest And Posttest

N	Pretest		Posttest		P(sig.)
	The mean value	Distribution	The mean value	Distribution	
33	34.39	Normal	67.73	normal	0.000 (significant)

Based on the data in Table 1 show that the value of the pretest and posttest were normally distributed after the results of testing for normality using non parametric statistics. The results analysis of sample t test derive significant value of 0.000. The significant value less than the value of α (0.05). It showed that the mean value of pretest and posttest of the higher order thinking skills students have significant differences. Thus, the higher order thinking skills students have increased on the animal kingdom subject matter. The magnitude of the increase in higher order thinking skills of students can be seen by calculating the normalized gain. The scores of pretest and posttest, mean pretest and posttest value, the gain and the n-gain in Table 2 below.

Table 2. Pretest, Posttest, Gain, and N-Gain Data

Pretest		Posttest		Gain	N-gain
Scores	Mean	Scores	Mean		
6.88	34.39	13.55	67.73	33.33	0.5

The results in Table 2, explain that the mean value of pretest (34.39), posttest (67.73) and was normalized (n-gain) of 0.5. It show that the increase in higher order thinking skills of students on the animal kingdom subject matter included the medium category.

In addition, the students were given a response questionnaire at the end of the lesson to determine the students' response while the learning process. The students' responses were obtained through the direct and closed response questionnaire with Linkert scale. The questionnaire consisted of 19 statements with 15 positive statements and 4 negative statements. The results of students' responses learning process are presented in Table 3 below.

Table 3. Response Students of Discovery Learning Model

No.	Statement	The nature of State	Response of Student			
			SD ^a	D ^b	A ^c	SA ^d
1.	Learning by using a model of discovery learning improve my learning spirit.	Positive	2	18	11	2
2.	Learning to use the model of discovery learning makes me lazy to learn.	Negative	3	20	7	3
3.	Learning by using a model of discovery learning improve my thinking skills.	Positive		7	23	3
4.	Learning to use the model of discovery learning improve my ability to solve problems.	Positive		8	20	5
5.	Learning through discovery learning models increased my understanding.	Positive	1	14	15	3
6.	Learning to use the model of discovery learning makes my learning process becomes more meaningful.	Positive	3	17	10	3
7.	The Animal subject matter very tedious to learn.	Negative	8	21	3	1
8.	Learning by using a model of discovery learning improve my analysis.	Positive	3	7	21	2
9.	Learning to use the model of discovery learning improve my creativity.	Positive	1	10	21	2
10.	Learning to use the model of discovery learning improve my work.	Positive		13	17	3
11.	Learning to use the model of discovery learning boost my confidence.	Positive	2	11	17	3
12.	Learning to use the model of discovery learning increases my curiosity.	Positive		9	21	3
13.	Learning through discovery learning models makes me difficult to understand the subject matter.	Negative	3	17	7	6
14.	How to learn to use the model of discovery learning makes me more active in learning.	Positive	7	11	13	2
15.	Learning to use the model discovery learning increase the sense of my responsibility.	Positive	3	14	12	4
16.	Learning to use the model of discovery learning makes the subject matter easier to understand.	Positive	8	15	9	1
17.	Learning by using a model of discovery learning more fun.	Positive	6	11	14	2
18.	The Animal subject matter very interesting to learn.	Positive	2	6	17	8
19.	Learning by using a model of discovery learning makes me bored.	Negative	4	17	10	2

a. SD = Strongly Disagree.

b. D = Disagree.

c. A = Agree.

d. SA = Strongly Agree.

The results of data response questionnaire in Table 3 above then changed in percentage form, the percentage is presented in Table 4.

Table 4. The Percentage of Amount Student in The Response Questionnaire

No.	Statements	Strongly Disagree		Disagree		Agree		Strongly Agree	
		Amount students	%	Amount students	%	Amount students	%	Amount students	%
1.	Positive	38	7.68	171	34.55	241	48.69	46	9.29
2.	Negative	18	13.6	75	56.82	27	20.45	12	9.09

Based on a student responses questionnaire in Table 4 above for a positive statement obtained as much as 9.29% the percentage who responded strongly agreed (SA), 48.69% responded agree (A), while the response who disagree (D) as much as 34.55%, and the response strongly disagree (SD) as much as 7.68%. Data questionnaire responses were obtained for the total percentage of negative statements as much as 13.6% and 56.82% student response stated strongly disagree (SD) and disagree (D), while students who responded agree (A) of 20.45 %, as well as responding strongly agreed (SA) as much as 9.09%.

Based on the explanation above, the higher order thinking skills students have increased the application of discovery learning model on the animal kingdom subject matter. This is indicated by the differences in mean values of pretest and posttest by using discovery learning model. Increased higher order thinking skills can be seen in Table 2 shows that the mean value of posttest is higher than the mean value of pretest. During the learning process, students are given a worksheet that presents real problems in life. The problems presented are emphasize students able to classify animals into phyla based on body shape, the body symmetry, the body cavity, and reproduction. It requires high level thinking skills to analyze problems in resolving the issue. Student worksheets were suitable with the discovery learning syntax model.

Discovery learning model provides the chance to engage actively acquire unknown knowledge to find their own concepts and principles through scientific activities. Teachers design the students activities to using mental process activities such as observing, classifying, measuring, suspect, analysing, and conclusion making to find concepts or principles [17]. Through this model, students find something they learned themselves [18]. This model emphasizes the students do various activities such as observing, asking questions, gathering information from various sources, conduct experiments, analysing and interpret data [19]. These activities are higher order thinking of cognitive process [7]. These activities train the learners to develop thinking skills to determine the problem, evaluate the problem, make a hypothesis, test hypothesis, making inferences, and making a solution in resolving the problem. This activity is to train students to solve problems. Problem solving is done through various activities to determine the problems, evaluate them, make a hypothesis, test hypothesis, making conclusion, and creating solutions. This is supported by the research results Chinedu & Kamin [13] and the results of research Yuliani & Saragih [20] which states that the discovery learning model are trained students to solve the problem by giving problems through analysing the information to determine the problem, evaluate the problem and create a solution. Troubleshooting is also building knowledge and skills of students from their own sources of knowledge gained [21]. This model has six stages, among others stimulation, problem statement, the data collection, the data processing, verification and generalization [12].

Stimulation stage, teachers provide stimulus by reading, questions, pictures, and videos of the issues presented. These stimulus desire to bring learners to find out the problems, so the students get the learning experience in observing the conceptual knowledge by reading and watching a situation or viewing pictures. Furthermore, at the identification problems stage students are required to identify problem by analysing and evaluating problems. In this activity, students are given the experience to ask questions, seek information and formulate the problem. This stage train students to resolve the

problem by finding the concepts of the lessons. Then in the data collection stage students are given experience to find and collect data / information. It can be used to find the problems solutions. This activity will also train them work together in groups to process information and to solve problems solutions. The data processing activities will train students to try and explore the competence of their conceptual knowledge to apply in the real life. At the verification stage directing students prove the truth data processing by activities in the preceding stage such as asking questions to classmates, discuss, when seeking information from relevant sources, and to connect it making conclusion. The conclusion last stage led students making conclusions from the problems presented. Students can also decide the facts obtained from the hypothesis then making conclusions [22].

In connection with this, the students are able to think critically to find their own knowledge of the concepts and principles by discovery learning model to solve the problems. That is, students are able higher order thinking to classify animals into phyla based on body shape, the body symmetry, the body cavity, and reproduction by using discovery learning model. Other than that, the students become more active and mutual cooperation among individuals to find knowledge related to the problems. It is also supported by the results data analysis of questionnaire responses showed that the discovery learning model bring up self-confidence, and high curiosity. In addition, students can improve the ability to think critically, analysis, and creativity in solving the problems. This shows that the discovery learning model increase high order thinking skills. In line with the research results Tondang & Sahyar [23] and Yuliani & Saragih [20] shows that the model of discovery learning increase to higher order thinking skills.

4. Conclusions

Based on the research and discussion above, it can be concluded that the discovery learning model increase the high order thinking skills of students on the animal kingdom subject matter. The increase in higher order thinking skills of students on the animal kingdom subject matter included in the medium category.

The model of discovery learning is able to bring up a positive attitude of students as it builds knowledge, self-confidence, cooperation between individuals, and a high curiosity.

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Acknowledgement

The authors recognize that many of those involved in helping to resolve this journal. Therefore, on this occasion the authors thank profusely to the supervisor who has guided me in this study. I would also like to thank the principal, a biology teacher, and the tenth grade of natural science 2 Srijaya Negara senior high school Palembang students.