Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.9, No.18, 2018

The Development of Lesson Plan of PBL Model to Promote Critical Thinking Ability and Students' Curiosity in Acid-Base

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Abstract
This research was aimed to develop Lesson Plan of PBL model to promote students' critical thinking ability and curiosity. This Lesson Plan was developed using Research and Development method with the following procedure: 1) Analysis of initial ability of initial students' critical thinking and curiosity, 2) Designing Lesson Plan based on PBL model, 3) Assessing of Lesson Plan developed, 4) Validating of critical thinking evaluation instrument, 5) Analysis of critical thinking and students' curiosity after treatment, 6) Limited testing to school using quasi-experimental methods with randomized control group pretest-posttest design. The data obtained were analyzed by the descriptive and inferential statistic. The effectiveness of implementation Lesson Plan developed was analyzed by using paired sample test analysis (T-Paired). The Learning of using Lesson Plan developed effectively improve students' critical thinking ability obtained p-value T-paired of 0.00062 because of p-value smaller than alfa 5% or by looking |t-calculation| > t- table where t-calculation is 4.0551 and t-table 2.0859. In the effectiveness of using of Lesson Plan developed on students' curiosity, there is significantly different before and after learning using Lesson Plan developed obtained p-value 0.45988 bigger than alfa 5% or by looking |t-calculation| < t-table where t-calculation 0.74624 and t-table 1.68385.
Keywords: Development Lesson Plan PBL model, critical thinking, students' curiosity, acid-base

1. Introduction

Graduation Competency Standards (GCL) set forth in the regulation of National Education Minister number 20 of 2016 for high school states that the graduation competencies should cover the three aspects of affective, knowledge, and psychomotor. Where one of the competencies in the dimension of knowledge is graduation must have factual knowledge, conceptual, procedural, and metacognitive at the technical level, specific, detailed, and complex. In the one of skill dimension, students are expected to have critical thinking skills while on the attitude dimension, students are expected to have the high curiosity about the topic of chemistry. Curiosity will encourage students to learn and find out independently about the material (Gruber, et al 2014). To realize the achievement of GCL in the graduation of High School and they are prepared with some subjects that support the achievement of the ability to think complex, critical thinking, and curiosity. One of its subjects is chemistry. The purpose of learning chemistry at High School level according to the National Board of Education Standard (2006) one of them is to train critical thinking ability toward the scientific statement. The ability of critical thinking on the students needs to be trained in the learning process through reasoning skills and concluding. Ennis (1996) states that critical thinking is a process with the aim that each student can make sensible decisions. Students who are accustomed to critical thinking will be able to make careful consideration in making decisions to overcome problems in everyday life. The existence of chemistry in the school curriculum as one of the basic science that can be used as a tool to grow up students' intelligence and to promote of thinking process to higher level thinking as well as a foundation to study various fields of science and technology in university (Pohan, 2013). Many studies prove that chemistry contributes and benefits to the quality of life and the development of the state in various aspects (Festus, 2012).

One of the learning models which can facilitate the development of students' cognitive abilities by applying the important principles of constructivism theory that learning must be meaningful in order to construct the active knowledge of the students so that it can direct the thinking process to the higher thinking skill is a model of Problem Based Learning (PBL) (Arends, 2004). Learning using PBL encourages students to describe what they know and integrate previous knowledge with nowadays while they work in collaborative groups to solve problems. Killey said (2005), using of PBL in the learning process in the classroom is not just to gain knowledge, but it can be a tool to develop students' thinking ability in the form of critical thinking ability, analysis, and problem-solving. Problem-based learning is developed to improve interpersonal skills, critical thinking, information seeking, communication, respect, and collaborative work (Sungur, 2006). In accordance with the learning characteristic of PBL, Barrow (1986), learning using PBL can shape responsible characters, accustomed to working in teams, train self-organizing skills and organize study groups, great curiosity so that learning directed by themselves to obtain new information.

According to Ennis (1996), critical thinking is a process to make sensible decisions about what is believed and done. The components used are reasonable decisions or reasoning, interpretation, analysis, causality, evaluation, and conclusions. So it is expected in the learning process, there is the increase in thinking skills from basic skills towards the development of high-level capabilities that include divergent and critical thinking skills. Critical thinking is thinking skills which are demonstrated by the ability to evaluate opinions or a statement using their own language and simplify communication so that it is more easily understood by others (Rainbolt and Dwyer 2012). Facione in Vacek, (2009) describes critical thinking as the reasoning used to make decisions based on information in the limited time and highly risky. There are five critical thinking elements: analysis, interpretation, inference, explanation, and self-regulation. Tyler (in Redhana, 2003) argues that experience or learning that provides opportunities for students to acquire skills in problem-solving can stimulate students' critical thinking skills. Critical thinking is an evaluative activity to generate a conclusion. Hogsette (2012) states that critical thinking is a skill that can be trained in the process of learning to conclude and re-communicate a topic using keywords to form a logical new statement based on reliable evidence and experience.

In Engel's book (2015), the first researcher, Daniel Berlyne studied human curiosity experimentally explained that curiosity is thought of as an instinct, like an appetite where hunger triggers us to seek food. When curiosity envelopes our feelings we try to satisfy that feeling by seeking information. So curiosity can be an expression of words and behaviors and encouragement to know more information. Curiosity is considered a basic instinct, an innate mechanism that enables individuals to learn about and master new things in their environment, promote survival, use of tools, and technological advancements. However, curiosity does not automatically develop into a well-developed interest because it is related to the degree of engagement that leads to the desired outcomes of learning and better mastery (Arnone, 2011).

2. Research Methodology

This research is a type of Research and Development that adapts the research steps of Borg and Gail development (2003), as follows: (1) Analysis of students' initial critical thinking ability about acid-base material obtained from pretest, (2) Analysis of students' initial curiosity about acid-base material obtained from questionnaire, (3) Results of teaching material analysis in accordance with the curriculum to compile Lesson Plan of PBL model, (4) Validation of Lesson Plan of PBL model by expert who has experienced teaching chemistry at least five years and has been certified, (5) Analysis of students' critical thinking ability after applying the PBL model learning, (6) Analysis of students' curiosity after applying the PBL model learning, (7) Limited testing to school using quasi experimental methods with randomized control group pretest-postest design. The population in this study was all students of class XI in private school Madrasah Aliyah UNIVA in Medan city. The sample is determined by purposive sampling.

3. Results

3.1 Description of students' critical thinking initial ability

The measurement of students' initial critical thinking ability of acid-base materials was measured using multiple choice two-tier instruments had been developed by researchers are adapted from Damanhuri et al. (2015). The instrument had been developed, validated of its contents by expert lecturers and chemistry teachers who had experienced teaching for more than 5 years. Questions are given in the form of multiple choice two-tier with indicator about the matter refer to the acid-base material as follows : 1) Explain the concept of Arrhenius acid-base, Bronsted Lowry, and Lewis based on experiment, 2) Identify the properties of acid and base solution with various indicators, 3) Explain the meaning of acid-base strength and summarize the pH measurement results of some acid and base solutions of equal concentration, 4) Explain the application of acid-base concepts in life. The number of critical thinking questions of acidic bases tested was 15 questions. The gain score of students' initial critical thinking ability level was presented in percentage form in table 1 as follows:

Table 1. Percentage of Initial Critical Thinking Ability Level

No	Percentage	Level
1	0%	Very High
2	5%	High
3	0%	Medium
4	24%	Low
5	71 %	Very Low

In the initial assessment of students' critical thinking ability, none of the students gained a very high level. From the high level of critical thinking was gained by one student namely 5%. None of the students got to medium level, namely 0%. Low level of critical thinking, there were five students by 24%. While the acquisition level of critical thinking of students was very low the number of 15 people by 71%. In the initial measurement of critical thinking ability level, the majority of students were at very low criteria of 71%.

3.2 Description of the student's initial curiosity before learning using the lesson plan of PBL model

The assessment of initial curiosity before learning used a questionnaire to assess the students' curiosity. Questions were formulated on the basis of each indicator to be assessed. The results of the initial curiosity assessment of students can be seen in table 2. The initial assessment of students' curiosity, there were seven students who had very high curiosity criterion of 33%, there were six students who had a high curiosity criterion of 29%, there were five students who had a curiosity high enough of 24%, and there were three students who had less high curiosity criterion of 14%.

Table 2. The Level of Students' Initial Curiosity

No	Percentage	Criterion of curiosity
1	33%	Very high
2	29%	High
3	24%	High enough
4	14%	Less high

3.3 The development of lesson plan PBL model and description of validation along with correction from validator on the Lesson Plan PBL model developed.

In Lesson Plan of PBL model developed, there were 17 learning objectives that became the target of learning with Lesson Plan of this PBL model. The seventeen of learning objectives cover the learning objectives of cognitive, affective and psychomotor domains which were elucidations of core competencies. The assessment of Lesson Plan of the PBL model developed was assessed by the five validators who had experienced more than five years of teaching. From eleven components of the assessment was found an average value of 2.92. Based on criteria of lesson plan assessment, the value of 2.92 is the criteria of lesson plan of the PBL model developed had been valid and no need to be revised. Followed is an assessment recapitulation of the 11 components of the five validators summarized in table 4.

Table 4. Results of Lesson Plan assessment of PBL models developed

No	The assessed component	Score
1	Subject identity	3
2	Core competency and basic competency	3
3	Formulation of indicators	2,75
4	Formulation of learning objectives	3
5	Selection of teaching materials	2,9
6	Selection of learning resources	2,85
7	Selection of learning media	2,9
8	Learning model	3
9	Learning method	2,9
10	Learning scenario	2,96
11	The design of learning assessment	2,85
Average		2,92

3.4 Description of the assessment as well as suggestions for improvement from validators toward the diagnostic question of multiple choice two-tier which had developed.

Questions that were developed amount 15 items of multiple choice two-tier adapted from Damanhuri's research et al, (2015) and then validated content by five validators. The validation of the content of multiple choice two-tier diagnostic was done by validators consisting of teachers and lecturers who have more than 5 years experience in chemistry teaching. The components of the questions which assessed consist of 4 components that were designed into an assessment instrument of critical thinking ability test consisting: 1) Subject identity, 2) Directions, 3) Writing rules, 4) Construction of questions. The validation of the contents of multiple choice two-tier developed was assessed by the five validators who have experience in teaching consisting of 4 components of the assessment was acquired an average value of 2.98. Based on the validation criteria of the matter's contents refers to the 4 components of the assessment of the matter's contents, the question is categorized as valid and does not need to be revised. The result of content validation (construct validity) can be seen in table 5 as follows :

Table 5. The result of content validity of the question

No	The assessed component	score
1	Subject identity	3
2	Core competencies and basic competencies	3
3	Formulation of indicators	2,99
4	Formulation of learning objectives	2,96
Average		2,98

3.5 Descriptions of students 'critical thinking ability which acquired after the learning and comparison of students' thinking ability before and after were taught with the Lesson Plan of PBL model developed.

After the learning process used Lesson Plan of the developed PBL model, the assessment of critical thinking ability used the test instrument that was developed. This was done to see if there was an increase in test value after treatment. As for the acquisition of students critical thinking ability after learning for the very high-level of acquisition, none of the students got it. At the high-level of thinking ability, there was only one student got the high level is the same student got the high level before treatment, however, increase the grade from 73 to 83. At the acquisition of critical thinking ability of medium level, there were nine people by 67%. At the acquisition of low critical thinking ability, there were five people at 24%. While at the acquisition of critical thinking ability very low-level there were six people at 29%.

Tabel 6. Summary of critical thinking ability before and after learning

No	Initial Score	Final score	Level
1	0%	0%	Very High
2	5%	5%	High
3	0%	67%	Medium
4	24%	24%	Low
5	71%	29%	Very low

From table 6 can be seen no one student who got the very high-level of critical thinking ability before and after learning. At the high-level of critical thinking, there was one student, who was at that level both before and after learning. At the medium-level of thinking were differences in percentage before and after learning where before the learning there was no student at the medium-level, but after learning there were nine students. In low thinking, there was no difference, while at very low-level reduced percentage from 71% to 29%.

3.6 Description of the student's curiosity in learning chemistry after learning and comparison of student curiosity before and after using the PBL learning model developed.

The assessment of students' curiosity on the acid-base material had been conducted after the Lesson Plan of PBL model which was developed was implemented. In this phase, curiosity assessment was done to determine whether the students' curiosity change toward better. The results of the assessment can be seen in table 7. In the students' curiosity assessment after learning, there were three students who had high curiosity criteria of 33%, there were five students who had high curiosity criteria of 24%, there were eight students who had high enough curiosity criteria of 38%, and there was one student detected had less high curiosity.

After learning using the lesson plan of the PBL model obtained students' curiosity data, then compared the acquisition of students' before and after learning. In table 7 can be seen a summary of data both before and after learning.

Table 7. Summary of student curiosity data before and after learning

No	Initial Score	Final score	Criterion character
1	33%	33%	Very high
2	29%	24%	High
3	24%	38%	High enough
4	14%	5%	Less high

There was the decrease in percentage at the very good level in Character data before and after learning. At the good level, there was an increase from 38% to 48%. In the level of enough increase from 28.5% to 38%. While at the level of less well, there was a decrease from 9.5% to 0%. The conclusions obtained from the decryption analysis differences in character data before and after learning was acquired character enhancement.

3.7 To measure the effectiveness of using lesson plan of PBL model used analysis technique of dependent sample T-test / Paired-Samples T-Test on the ability of critical thinking and character.

The learning effectiveness measurement by using the Lesson Plan of the PBL model was used analysis technique of dependent sample T-Test / Paired Sample T-Test on critical thinking ability was obtained by using the increase of critical thinking from the gain value before and after learning with PBL. We can see the summary of

t-Test in table 8.

Table 8. Summary of t-Test: Paired Two Sample for Means

	Before	*After*
Mean	70,23809524	75,95238095
Variance	316,1904762	184,047619
Observations	21	21
Pearson Correlation	0,905806867	
Hypothesized Mean Difference	0	
df	20	
t Stat	-3,293547878	(T hitung)
P(T<=t) one-tail	0,001814864	
t Critical one-tail	1,724718243	
P(T<=t) two-tail	0,003629727	(p Value)
t Critical two-tail	2,085963447	(T Tabel)

From table 8 was obtained T-table 2.08596 with the p-value of T-paired with 0.00062. Therefore, the p-value is less than alpha 5% or by looking |T-calculation| > T-table where T-calculation is 4.0551 and T-table 2.0859 then the decision there is significantly different students' critical thinking ability between before and after learning. The effectiveness measurement by using the Lesson Plan of the PBL model used analysis technique of paired samples T-test (T-Paired) on the curiosity of students was obtained T-table in 2,08596 with p-value T-paired of 0,00363. From the data processing was obtained p-value 0,00363 smaller than Alpha 5% or by looking |t-calculation|< t-table where t-calculation 3,29355 and t-table 2,08596 hence decision there is significantly different students' curiosity between before and after learning.

4. Discussion and Conclusion

The identification of students' thinking ability after learning using the Lesson Plan PBL model was found no students at the critical thinking level was very high. At the high level of thinking ability, there was one student and the same student got the high acquisition rate before treatment. It's just that the student had increased the score from 73 to 83. In the acquisition of medium-level critical thinking ability, there are 9 people namely 67% where before the learning there is no one student at that level. At the low thinking level, there was no difference before and after treatment were 5 people for 24%. While at a very low level, it decreased the percentage from 71% to 29%.

In the acquisition students' curiosity data before and after learning obtained the same percentage on the level of very high curiosity was 33% but there was the increase of curiosity score from 6 to 7 students. At the high level, there was the decrease of percentage at the high level from 29% to 24%, but it had risen at the level of high enough from 24% to 38%. While the level of less high decreased from 14% to 5%. The conclusions were obtained from the analysis of the descriptive data of curiosity before and after learning was increased.

In Lesson Plan of PBL model developed, there were 12 learning objectives that became the target of learning with Lesson Plan of PBL model. The seventeen objectives of learning were details of the learning objectives of cognitive, affective and psychomotor domains contained in core competencies. Learning objectives in the cognitive domain are designed to strive to develop students' critical thinking ability. In learning using PBL, students are faced with the problems associated with real problems in life and is expected to solve problems with the instructions that have been prepared on the Worksheet. After students are able to solve the problems created, the student must also be able to communicate his ideas. The ability to think critically is a skill that must be taught and trained to students because this ability does not automatically exist in students' cognitive abilities. In addition, the form of evaluation of critical thinking learning outcomes should also be part of formative assessment (Tittle, 2011). According to the University of Sydney, the Learning Centre (2013): need the learning design to appear critical thinking skills by developing skills as follow: 1) Interpretation: understanding the importance of data and clarifying meaning, 2) Analysis: describing information and combining in various ways 3) Reasoning: creating arguments through logical steps, 4) Evaluation: assessing the merits, credibility or strength of judgment.

In the affective domain learning, PBL strives to construct students' curiosity about the material being studied. As Arnone (2011) had declared that the students' curiosity does not arise automatically requires an effort to grow it. Furthermore, curiosity will develop into individual interest because of the associated interaction and involvement in learning that will lead to the desired results of learning and mastery of the material. From the result of research conducted was obtain the improvement of students' critical thinking and curiosity using Lesson Plan PBL model developed. That getting the maximal result, the implementation of PBL should be done with longtime allocation because it needs to get detail information through observation and interview with individual students so as to get accurate information about students' responses to get learning using PBL.

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