# Constructivism of Problem-based Learning Failure in Increasing Students Critical Thinking and Strategy of Cognitive Conflict

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Keywords: Critical Thinking, Curiosity, Problem Based Learning.

Abstract: The aim of this research was described and analyzed the apply constructivism based on Problem-based learning model and cognitive conflict strategy for the increasing ability of MCT (mathematical critical thinking) and MCA (mathematical curiosity ability). This research adopted a quasi-experimental with pretest-posttest control group design. This research used the design of the mixed method with sequential explanatory strategy. The population consists of students teachers of Mathematics Education Program of Riau Islamic University. The instrument of collecting quantitative data is essay test and questionnaire and interview sheet, observation sheet to collect qualitative data. The findings show that (1) no difference MCT ability and MCA disposition with taught by Problem based learning model and cognitive conflict strategy with explicit direct instruction (EDI) approach, namely; high, medium, low; (2) but in thinking process development in teaching and learning, were founded that there were difference MCT ability and MCA dispositions with have taught by problem-based learning model and cognitive conflict strategy(high, medium, low); It known through observation, interview and result in teaching and learning.

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## 1 INTRODUCTION

Critical thinking is a one skill must be owned by every person. With critical thinking, students will always be careful in carrying out something and make a decision based on a found problem. In Higher Education, this capability is needed for each course requires students to can think critically, because by using critical thinking, students should solve the problem is given, including a course on Number Theory. The results of research Lee, Wootton, Chang, and Phan ()(Kondakci and Aydin, 2013) showed a positive relationship between critical thinking and academic achievement. Students need critical thinking when facing a challenge, and he can make decisions, evaluation, and consideration well the received information, used for solving the problem, make plans for actioning. This capability enables students can find alternative what he thinks is important and consider to make decisions in order to solve the existing problems.data or information can be used make conclusions that are true and the same time see a contradiction or whether there is any consistency or irregularities in the information. In critical thinking, people analyze and reflect on the results of thinking. In short, someone who thinks critically always be sensitive to the information or situation at hand and tend to react to situations or information.

About curiosity, Suhadak (2014) states that curiosity is characterized by the activity of searching and finding that appear enthusiastic to learn, find out and investigate. Suhadak opinion is also supported by McElmeel (2002) hat the information about the curiosity of student can be known from the student motivation for learning, investigating, and finding out. This variable is important developed in the teaching and learning process in the mathematics classroom. because curiosity is part of the motivation (Shellnut, 1996). Elliott, et al (2000) suggest that an important role curiosity in learning more is that curiosity can encourage and build knowledge learners (Suhadak (2014). Therefore, the increase of curiosity in the classroom should be the goal of mathematics learning. Because when students have a high level of curiosity on something, the closer they with the learning environment, a classmate even in group study (Binson, 2009).

To develop students' critical thinking and curiosity required a study that investigates all aspect about critical thinking and curiosity, which believed that learning directed to learners who are dominant



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and nature educators and guiding learners in teaching and learning. One allegedly adopts learning is problem-based learning (PBL) and cognitive conflict strategy.

History about Problem-based learning (PBL) begun from medical education at the faculty of medicine at McMaster University in Canada in the mid-1960s. This concept as soon as adopted by three other medical schools, the University of Limburg at Maastricht in Netherlands, University of Newcastle in Australia, and University New Mexico in the United States (G. Camp, 1996). According to (Chyn, ) stated that the problem-based learning approach has a powerful pedagogical and teaching and learning system explicitly and directly teach critical thinking skills to students various level. G. Camp (1996, p.3also stated that the constructivist view of learning facilitates, PBL can be adopted from pre-school to post-graduate training and broadens its application far beyond medical training.

From its early history, PBL in the medical world and has been proved growing, then the other in education had been developed as well, especially in mathematics education. among others Orhan Okinoğlu and Rohun (Tandogan and Orhan, 2007) apply PBL in his research concluded that PBL affects the outcome of learning, understanding concepts, and attitudes of learners. While research Sheryl MaCSath, John Wallace, Xiaong Chi, (2009) applying Based Learning Active Learning in his research to the principles namely, a) use small groups to collaborate resolve the problem, b) students as a learning center, c) use a real problem and d) the teacher as a facilitator. His research concluded that the Active Learning Based Learning can improve learning outcomes, attitudes, and concepts of learners.

PBL is based on the cognitive constructivist learning theory Piaget (1896-1980) and the social constructivist Vygotsky (1896-1934) (Orey, 2010). Piaget stated that the cognitive structure as schemata. This theory explains that learning based on the cognitive development of children. While Vygotsky said that learners in constructing the concept need to pay attention to the social environment. In Vygotsky's theory, there are two important concepts that Zone of Proximal Development (ZPD) and scaffolding. According to (Herman, 2006), ZPD is the distance between the actual development level is defined as the critical thinking ability independently and the level of cognitive development is defined as the ability to think critically under adult guidance or in collaboration with peers whose capacity is higher.

Besides PBL, strategy of cognitive conflict can also reinforce students' critical thinking skills, Cognitive Strategies can be defined as a mental procedures used to achieve the goal of cognitive ranging from the most instinctive as sensing up on the ladder of higher cognitive i.e. observation, save and recall, imagination and thinking (Surya, 2015). (Bruner, 1971; Gagne, 1985) in the Sun (2015) to interpret cognitive strategy refers to the process used in finding and solving problems. While cognitive conflict can be interpreted as there is a common perception (opinion) that raises a conflict between two groups. Then if the individual happens indecision in choosing one or more choice from a selection, the individual has a conflict.

Of cognitive strategies and cognitive conflict combined into cognitive conflict strategy. This strategy is one of the constructivism learning. Piaget constructivist theory states that when someone builds a science, it is to establish a balance higher knowledge required assimilation, namely contact or effective cognitive conflict between the old concept with a new reality (Woolfolk, 1984). The views Piaget stated that learners are actively reorganizing the knowledge that has been stored in the cognitive structure. The development of cognitive structures one with adaptation in the form of assimilation and accommodation.

According to (Santrock, 2002), assimilation is a thinking process by which information coming into the people brain and changed in a way to match the structure of the brain itself. While the accommodation is the process of changing the structure of the brain because of the observations or information. More Santrock explains about the assimilation and accommodation, that there are two steps done in the process of learning to change the concept. The first phase of the second stage of assimilation and accommodation. With the assimilation of students uses the concepts they already have to deal with the new phenomenon. With accommodation learners change the concept that no longer fit with the new phenomenon they face.

Stimulation of cognitive conflict in learning will greatly assist in the assimilation to be more effective and meaningful for learners. For that approach to cognitive conflict needs to be done in the mathematics learning strategy. (Dahlan and Rohayati, 2012) says that cognitive conflict rarely occurs in the context of collaborative but in the personal context. When collaborating is a time to solve conflicts that arise in the individual learner (personal). Furthermore, Ismaimuza (2010) states that the cognitive conflict strategy commonly has a pattern such as exposing alternative framework, creating conceptual cognitive, encouraging cognitive accommodation.

## 2 RESEARCH METHODOLOGY

The quasi-experimental approach was used in this research (Creswell, 2010; Cohen, 2007) which aims to acquire numeric data on MCT and MCA students have taught using PBL and Cognitive Conflict Strategy (PBLCCS) and have taught using EDI. Design research is using a combination of quantitative and qualitative methods, known as a mixed method with sequential explanatory strategy (Creswell, 2010). The collection of data carried out by two way, namely; quantitative during the experiment in the classroom and qualitative after quantitative analysis have done.

## 3 RESULT

### 3.1 The Quantitative Data and Statistical Tests of Critical Thinking Skills

Based on data analysis to increase students' critical thinking skills mathematically, can be described in the following Table 1.

Table 1: Gmean and standar deviation of MCT

| Class | N | GMean | SD | Error |
|---|---|---|---|---|
| EC | 25 | ,4987 | ,22500 | ,04500 |
| CC | 26 | ,4772 | ,21175 | ,04153 |

From Table 1, it can be seen that the gain-average (Gmean) and the standard deviation of critical thinking skills students experimental class (EC) and the control class (CC) is not much different and tend to be relatively the same. Furthermore, by using statistical tests, will be the homogeneity significance of variances and differences in an average of improvement of critical thinking ability (MCT) by using the statistics software namely SPSS 20.00.

Table 2: homogenity test of variances and MCT enhancement

| Levene's Test for Equality of Variances | |
|---|---|
| F | Sig. |
| ,131 | ,719 |

From Table 2, test results Lavene, obtained by means sig sig = 0.719 $\geq \alpha$, where $\alpha$ = 0.05. In accordance with the criteria of testing, accept H0, meaning that both classes of homogeneous variance. From Table 2 also shows that Sig = 0.727 $\geq \alpha$, thank H0, meaning that there is no difference critical thinking skills between experimental class and control class.

### 3.2 The Quantitative Data and Statistical Tests of (MCA) Improvement

As for seeing the results of an answer to a mathematical curiosity of students, can be seen in Table 3 below:

Table 3: Recapitulation of student response to the questionnaire data for all indicators MCA.

| | Positive statement (+) | | | | Negative statement (-) | | | |
|---|---|---|---|---|---|---|---|---|
| | SL | SR | JR | TP | SL | SR | JR | TP |
| N | 256 | 548 | 368 | 17 | 34 | 11 | 418 | 287 |
| % | 22 | 46 | 31 | 1 | 4 | 13 | 49 | 34 |
| JS | 68 | | | | 83 | | | |
| $\mu$ | 76 | | | | | | | |

Information :

SL : Always

SR : Often

JR : Rarely

TP : Never

JS : Percentage of SL + SR and JR + RP

$\mu$ : Average of Percentage

Table 4: Gmean and standar deviation of MCA

| Kelas | N | GMean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| EC | 25 | ,094 | ,242 | ,04847 |
| CC | 26 | ,028 | ,294 | ,06603 |

Information:

EC : Experiment Class

CC : Control Class

Gmean : Gainmean

Based on the table, it can make a conclusion that EC and CC almost no different because the different of GMean only in a small range. It's mean, there is no difference in the ability of EC and CC. This result can be proven on Table 6 Based on SPSS software analysis.

From table 6, from Lavene test results, obtained by sig = 0.576 $\geq \alpha$, where $\alpha$ = 0.05. In accordance with the criteria of testing, accept H0, meaning

Table 5: Test Statistics for homogenity and enhancement of ability curiosity

| Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|
| F | Sig. | t | df | Sig. (2-tailed) |
| ,576 | ,451 | 1,865 | 49 | ,068 |

that both classes of homogeneous variance.From Table 6 also shows that sig (2-tailed) = 0.068 $\geq \alpha$, accept H0, in other that no difference in upgrading mathematical curiosity experimental class students with grade control.

## 3.3 Description of the Critical Thinking based on the Students' Academic Ability Level

For further analysis of the data based on the students' academic ability level is a student group of high, medium and low, can be described the results of the pretest, posttest and N-Gain of critical thinking skills of students:

Table 6: The description of the pretest results, posttest and N-Gain of (MCT).

| Group | Rerata Pretest | | Rerata Postest | | Rerata NGain | |
|---|---|---|---|---|---|---|
| | EC | CC | EC | CC | EC | CC |
| High | 9,0 | 4,5 | 24,5 | 22,5 | 0,75 | 0,70 |
| Middle | 3,05 | 2,09 | 13,05 | 17,8 | 0,36 | 0,55 |
| Low | 2,00 | 1,40 | 7,50 | 9,00 | 0,19 | 0,26 |

Information :
Rerata : Average

From table 6, it can be seen that NGain critical thinking skills among groups of EC and CC is not much different, for medium and low group CC group, Ngain is higher than the EC.

## 3.4 Qualitative Analysis of the Critical Thinking Process Mathematical and Mathematical Curiosity

Based on the result of observations and interviews, it can be described how the process of critical thinking and mathematical curiosity. This result can be seen pada Table.

Table 7: Result of observations from critical thinking and mathematical curiosity process based on group

| Group | Observation result | |
|---|---|---|
| | Critical Thinking Process | Curiosity Process |
| High | students were excellent in asking a question about the given task. Students give opinions when the discussion was carried out. Student as soon as asked to lecturer if there are the confused problem have found during teaching and learning process | most students asked when there is a thing wasn't understood. If observing from the spirit in finishing the given task, students very enthusiastic in learning |
| Middle | the student asked his friend in the group, show students have a curiosity on the settlement of the given problem | The students ask a friend in the learning group, if students can't get a satisfactory answer, the students can get an answer from the lecturer |
| Low | The students follow a group discussion and l isten well | no task is given in a group discussion |

## 3.5 Interview Result and Assessment in Learning Process

All students interviewed about the process of critical thinking about the outcome in answering the questions provided. The results of these interviews were divided into three groups: a group of students of high, medium and low group students.

Table 8: Results of interviews about the critical thinking process mathematical and mathematical curiosity group of students of high, medium and low

| **Group** | **Interview result and Assessment in learning process** | | | |
|---|---|---|---|---|
| | **CTPR** | **CTA-Mean** | | **CAt** |
| | | **EC** | **CC** | |
| High | Problem is given to make us think critically, create confusion, but challenged to find solutions. Enthusiastic investigated in a group. Worksheets provided are helping the understanding of the material provided | 2,59 | 2,09 | The question make curious, the question makes sense to know what the answer is. Curious about the answer. Worksheets are given to stimulate us to better understand it, has never been given a worksheet like this |
| Middle | The question makes us have read more carefully, confusing too, but want to know what the solution crate. Give an explanation beforehand | 2,46 | 2,28 | The question make curiosity arises, what about the intent, but sometimes confused too, yet want to know what the answer |
| Low | Very confusing question and the question should be read many times | 2,33 | 1,88 | not understand what that means because, confusing and intriguing |

Information

CTPR : Critical Thinking Process and Result

Cat : Curiosity Attitude

# 4 DISCUSSION

Based on the quantitative analysis of mathematical critical thinking and curiosity did not differ significantly from those taught using PBLCCS in the experimental class compared to using EDI in the control class. This means that the application PBLCCS not give significant effect. From observations on the application of this PBLCCS, students have not been able to construct their own what will be learned without considerable assistance from educators (lecturers). From the interviews, their hopes of learning, first there is a detailed explanation, there is setting the example, new students are given the opportunity to learn in a group. Most of the students are unfamiliar also in learning no explanation is given in advance or if there is an explanation, it is very minimal, so that they do not know what to do about a given task. In this case, the student has not been able to independently build their knowledge, need more detailed assistance of educators in understanding the material provided. Yet effective means minimizing guidance to improve critical thinking skillsThis result appropriate with previous studies of (Sweller, 2006), in a study that minimizes instruction or teaching tends to be ineffective. Over half a century of empirical research on this issue has given clear evidence and guidance for teaching that minimizes significantly less effective and efficient than guidance specifically designed to support the cognitive processes needed for learning. Also (Camp, ) states whether PBL is just a paradigm shift from teacher learning center to the student center or just a mere fad? So results of research from (Zetriuslita, ; Zetriuslita et al., 2015) about profile of mathematical critical thinking ability student and (Zetriuslita et al., 2015) about profile of mathematical curiosity ability student still low. It means that we have to can something to increasing both of them.

But in the process, critical thinking skills so evident and mathematically when learning takes place, it is concerned with their thought processes in understanding a given task. They eagerly asked, investigate what should be done, seen also their sense of confused but curious about the completion of a given problem. Likewise curiosity (curiosity) developed this PBLCCS like the questions they convey, 'bu this mean anything? "," A way to resolve how bu?' And other questions indicating they are keen to find out the solution. However, in the process, they are very enthusiastic in solving challenging problems, they are curious, challenged that in their discussions eager to collaborate, although not yet gave the impact to increase critical thinking skills.

# 5 CONCLUSION

Based on the result, it can be concluded that PBL and cognitive conflict strategy can't give a satisfactory in improving the student critical thinking and curiosity, but if see from the process of critical thinking and curiosity during the learning, the results show that the process the development of critical thinking and the attitude of curiosity towards mathematics run well during teaching and learning process. Educators expected can implement this concept in a good situation and the right way so it is expected to have an influence on students critical thinking ability

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