The Development of Problem Based Learning Model to Construct High Order Thinking Skill Students' on Mathematical Learning in SMA/MA

Edi Syahputra[*]   Edy Surya

Faculty of Mathematics and Natural Science, State University of Medan, Indonesia

*Email: edisyahputra21@yahoo.com

Abstract

This research is a development research of learning model that aimed to develop problem based learning model to construct high order thinking skill of students on mathematical learning in SMA/MA. The experiment subject and dissemination were the students in the first grade of SMA/MA in three subprovinces of North Sumatera, those are SMA Swasta Yapim Taruna Stabat subprovince Langkat, SMK Negeri 6 Medan, SMA YPK Medan, and MAN Lubuk Pakam subprovince Deli Serdang. The data collecting instruments in this research are questionnair, observation paper, interview guidance paper, mathematics book for students in the first grade of SMA/MA, mathematics book for teacher guidance and pre- and posttests instrument. This model development was adopted from Thiagarajan, Semmel & Semmel model. Concretely, learning model was implemented to increase high order thinking skill of SMA/MA students for solving mathematical problem. Moreover, this research aimed to produce mathematics book for students in first grade of SMA/MA and mathematics book for teacher guidance that consist of structured steps for solving mathematical problem based problem solving to construct high order thinking skills. The experiment result shown that there is a significant improvement of mathematical problem solving skills of student.

Keywords: Learning Model, High Order Thinking Skills

1. Introduction

The Observation result shown that current mathematical learning model in SMA was not relate to clearly learning theory. During learning process in clasroom, students were given routine problems that can be solved by using simple analysis and mecanistic solution. Almost all mathematical learning process in SMA was starting by giving definition, formula, example and ending by giving exercise. Sometimes there was mathematical problems proving that can be solved by using simple sketch or picture. This condition can't generate student's creativity or critical thinking.

Beside of that, learning process were not familiarize students to think axiomatic deductive, mathematical books in learning process was not support student to think axiomatic deductive. Mostly, mathematical learning process in SMA guided students to memorize, solve mathematical routine problem and use simple analysis inductively by following existing example. Ironically, teacher teach students by following steps and presentation that given in mathematical book which present monotonically, without considering student cognitive development level. But, mathematical learning required innovation and creativity both teacher and students. Because of that, Sumarmo (2005) said that problem solving skills of student is low.

The finding shown that 40 students in the fourth semester in college can't prove that axiomatic deductively that "the sum of a triangle angles is 180^0". Student presented this proving by demonstrating a piece of paper in the form of three separate corner of the triangle. These three pieces of paper are arranged side by side in a straight line.

$$180^0$$
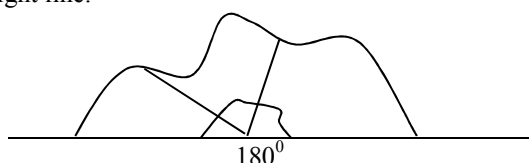
This finding shown that students were not familiar to solve mathematical problems axiomatic deductively. The Students were also not familiar to solve mathematical problem by writing what information known from the problem and what targets would be achieved.

Kholilah (2012) found in her research that mathematical problem solving skills of students still far from the expected. The problem that arises was the uncertainty of students to translate problem into what information known. Students have not been able to relate what information known with what problem in questions. Consequently, students can't make mathematic model from the problems.

Mathematical learning was consist of non routine problems and need not routine solution. Problem based learning is a learning innovation that can increase creativity and critical thinking. Siregar (2011) said that the concept understanding of student that teach by using problem based learning is better than that teach by using

regular learning. Beside of that, Suryadi (2005) said that mathematical problem solving is one of important mathematical activity either by teacher or students in all level from elementary until senior high school.

2. Research Method

The kinds of this research is development research. The steps of learning model development was following the procedure of Thiagarajan, Semmel & Semmel learning model development (1974).

According to Thiagarajan, Semmel & Semmel (1974), development model that used refer to four D-Model. Four D-Model consist of four steps, those are: define, design, develop and disseminate. Description of development result can be described below.

Step 1: Define

The purpose of this step is to set and define learning activity by analysing the aims and subject matter restriction. This step would be decribed five activities, namely front-end analysis (mathematical curriculum analysis), student analysis, concept/ subject matter analysis, task analysis, and formulate learning objectives. Define step can be described below:

a. Front-end Analysis

This analysis aimed to analyze basic problem encountered in the learning model development. Some points to consider in front-end analysis is 2013 curriculum and learning theories based on problem based learning.

b. Student Analysis

This analysis was conducted by considering characteristics, skills and prior knowledge either individual or group. This analysis was also consider student characteristic based on design and development of learning materials. This characteristic consist of skill and background, experience, attitude to learning topic, media selection, format selection, languange and student cognitive development.

c. Concept Analysis

This analysis was aimed to identify, specify, arrange relevant topic sistematically. This topic would be developed and then tried to implement by using problem based learning based on front-end analysis.

d. Task Analysis

Task analysis is an identification of student skills which need in mathematical curriculum of Senior High School in 2013 curriculum

e. Specification of Learning Objectives

The purpose of this step is to convert objectives from task analysis, concept analysis become specific learning objectives expressed with student behaviour in learning.

Step 2: Design

In this step was designed learning model and supporting instrument like student mathematical book based problem based learning and teacher guidance book. The result of this step is called **Draft-1**. Activities in this step are identify indicator of learning objectives and basic competency, set problem based learning as basis of mathematical learning model, initial design and arrange draft of mathematical book of the first grade in senior high school.

Step 3: Develop

There are four activities in this step, they are:

a. Validation

Develop step was starting with expert validation. Validation was conducted to draft of student's book and teacher's guidance book which designed in second step (Draft-1). Validation was conducted to content of learning materials, languange and format which used. Validation was done by experts in Mathematical, Indonesian languange experts and school mathematics learning theory experts. Aspects which observed are: the scientific approach steps (like observing, asking, trying, associating and communicating) stand out in student's book and teacher guidance book, the implementation of problem based learning stand out in those books, the subject matter arrange hierarchy, the sentence in those books easy to understand, the sentence in those books have duplicated meaning, those books have interesting content and appereance, problem has variation, the problem include as contextual problem and the sentence in exercise have duplicated meaning.

b. Revision

After assessing process from expert was done, then the nex process was revise instrument and learning materials. The suggestion from validator was used to make learning materials and teacher guidance book better. This revision was called revision-I.

c. Implementation

After conducting revision-I to learning materials and teacher guidance book, the next step is conducting limited implementation. This implementation was called limited because it depend on schedule of the subject matter in

implementation school, so that not all subject matter in student's book can be implemented. The implementation was conducted in four schools from three sub-provinces in North Sumatera namely SMA Swasta Yapim Taruna Stabat Langkat subprovince, SMK Negeri 6 Medan, SMA YPK Medan and MAN Lubuk Pakam Deli serdang subprovince. The aspects that observed in implementation process are the sentence in student's book easy to understand by students, the sentence in student's book have duplicated meaning, student's books have interesting content and appereance, problem in student's book have variation, and the sentence in exercise easy to understand. Beside that, the implementation was also conducting in process and student's activity in learning process. Aspects which observed are: the student actively observe subject matter in their own group, the students actively to ask in their own group, the student actively try to solve problem in student's book, can the student relate information from problem with planning to solve problem, students communicate their idea with group member, student do activity which not related to learning process, teacher organize student in group, teacher give scaffolding, teacher give answer based on student's question, teacher give instruction to students observing, asking, trying, associating, and communicating.

d. Revision-II

After conducting implementation, the next step revision to content of learning materials and teacher's guidance book. Revision was conducted based on findings of implementation result. In this step, the mistake in languange aspect was revised, so that there is no duplicate meaning in sentence. Graph or picture was made clear, so that it has meaning which is understood by student. The format was also revised become better.

Mathematics learning process in classroom has been following problem based learning. The steps of problem based learning are based on four steps of problem solving by Polya (1971), those are: (1) understanding the problems, (2) planning the solution, (3) solving the problems based on planning in the second step, (4) looking back the result. To develop student skills in this problem solving, teacher has to design learning process by provide problem solving experience that need variate strategy to problem given.

The concrete implementation of problem based learning steps can be divided as follows: (1) writing what is known aspect in problems, this aspect as initial capital to solve problem, (2) writing what is asked in problem, this aspect is the goal, (3) writing mathematical model from te problem by using what is known aspect from problem, (4) solving the model in the third step, (5) looking back the result.

There are some aspects that have consider to teach problem solving like time, planning, sources, technology role and class management. The time aspect divided into time to uderstand problem, time to explore the problem, and time to think the process of problem solving.

Sanjaya (2008) said some advantages problem solving approach, those are:

(a) Problem solving is a good technique to undestand the subject matter
(b) Problem solving ia a challenging for student skills and give satisfaction to find the new knowledge for student
(c) Problem solving can increase student learning activity
(d) Problem solving can help student how to transfer their knowledge to understand real life problems
(e) Problem solving can help student to develop their new knowledge and responsible in their learning process. Problem solving also can motivate to evaluate their own result and learning process
(f) Problem solving learning is a joyful learning and liked by students
(g) Problem solving can develop student skills to think critically and to adapt with new knowledge

Furthemore, Nainggolan (2009) said that there are some reasons why problem solving is an important aspect and can make learning process effective and creative. Those aspects are:

a) By using problem solving in learning, the subject matter can be implemented
b) Practice and make student familiar to think diffrent from usual
c) Problem solving in learning can give opportunity and can motivate student to discuss with their friends to find the solution of problem
d) Problem solving can also motivate students to construct their own theory by thinking creatively and critically, testing their teory, testing their friend theory, deleted if the theory not consistent and try others
e) Problem solving in learning can motivate and arise curiosity of student to find the solution of problem
f) Problem solving skill in learning need to practice to student because people always need that skill to face and solving problems.

3. Result and Discussion
3.1 Result

Research result is one package mathematic learning model in the first grade of senior high school that consist of some instruments, those are questionnair paper, observation guidance paper, interview guidance paper, mathematics book for student, mathematics book for teacher guidance and pre- and posttest instrument.

The result of implementation this learning model package in three subprovinces are: From 37 students

first grade in SMK Negeri 6 Medan, there are 32 students (87%) said that the sentence in student book easy to understand, 21 students (57%) said that the sentences in that book have no duplicate meaning, 35 students (95%) said that the content apperance of book is interesting, 35 students (95%) said that the problem in student book is varying and 23 students (56%) said that the sentences in book easy to understand. In SMA swasta YAPIM stabat that has 41 students, there are 23 students (56%) said that the sentences in book easy to understand, 25 students (61%) said that the content apperance of book is interesting, 40 students (98%) said that the problem in student book is varying and 15 students (37%) said that the sentences in question easy to understand.

In SMA YPK Medan, there are 37 students and the result is 31 students (31%) said that the sentences in book easy to understand, 24 students (65%) said that the sentences in that book have no duplicate meaning, 16 students (43%) said that the content apperance of book is interesting, 36 students (97%) said that the problem in student book is varying and 25 students (68%) said that the sentences in question easy to understand. In MAN Lubuk Pakam, there are 32 students and the result is 30 students (94%) said that the sentences in book easy to understand, 31 students (97%) said that the sentences in that book have no duplicate meaning, 20 students (63%) said that the content apperance of book is interesting, 24 students (75%) sait that the problem in student book is varying and 31 students (97%) said that the sentences in question easy to understand.

The other result from the implementation is mathematical problem solving skill of students increase significantly. This improvement was seen from the different of normalized gain between students score in first and second cycles. The average of N-gain in the first cycle is 0,309 and the second cycle is 0,430. By using t test, it can be concluded that there is significant increasing between both of them.

3.2 Discussion

From conducted implementation, learning activity process took place fluently. Students actively to observe subject matter in their group. Students actively to ask in their group, try to solve the problem in student's book, students can relate information from problem and students can communicate their thinking result with their group member actively. Significantly, there is no student do activity that not relate to learning process. From the observation for learning process, teacher organize student in group that consist of three or four students, students give scaffolding, teacher give precise answer for student's question, and teacher always instruct students to observe, ask, try, associate, and communicate the subject matter in their own group. after that, each group presented the group work result in front of class. Quantitatively, there is significant improvement of mathematical problem solving skills of students.

4. Conclussion

Based on this research result, learning model and all related instrument were recommended to be implemented in mathematic's learning in first grade of senior high school. One of the the important and dominant instrument in this model is student's book and teacher guidance book. So that, students will familiar to construct high order thinking in mathematics learning.

References

Kholilah. D. (2012). *Perbedaan Kemampuan Pemecahan Masalah dan Disposisi Matematis Siswa yang Diajar dengan Pembelajaran Matematika Realistik Dibandingkan dengan Siswa yang Diajar dengan Pembelajaran Biasa di Kelas VIII SMPN 2 Stabat T.A. 2011/2012*. Medan: Skripsi Universitas Negeri Medan

Nainggolan, H. (2009). *Pendekatan Problem Solving Untuk Pengajaran Operasi Riset di SLTA*. Medan: Tesis PPS-USU Medan

Polya, G. (1971). *How to Solve It: A New Aspect of Mathematics Method*. New Jersey: Princeton University Press

Sanjaya, W. (2008). *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan*. Jakarta : Kencana Prenada Media Group.

Siregar, N. (2011). *Penerapan Pembelajaran Berbasis Masalah untuk Meningkatkan Pemahaman Konsep dan Pengetahuan Prosedural Matematika Siswa SMP*. Medan: Tesis Universitas Negeri Medan

Suryadi, D. (2005). *Penggunaan Pendekatan Pembelajaran Tidak Langsung serta Pendekatan Gabungan Langsung dan Tidak Langsung dalam Rangka Meningkatkan Kemampuan Berpikir Matematik Tingkat Tinggi*. Bandung: Disertasi UPI Bandung

Sumarmo,. (2006). *Pembelajaran Keterampilan Membaca Matematik pada Siswa Sekolah Menengah*. Bandung: FPMIPA UPI.

Thiagarajan. Semmel & Semmel (1974). *Instructional Development for Training Teachers of Exceptional Children*. A Sourse Book. Blomington: Central For Innovation on Teaching The Handicapped

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/   All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar