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The Development of Learning Model Based on Problem Solving to Construct High-Order Thinking Skill on the Learning Mathematics of 11th Grade in SMA/MA

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Abstract
This paper is a summary study of team Postgraduate on 11nd grade. The objective of this study is to develop learning model based on problem solving which can construct high-order thinking on the learning mathematics in SMA/MA. The subject of dissemination consist of Students of 11th grade in SMA/MA in 3 kabupaten/kota in North Sumatera,namely: SMA Swasta Yapim Taruna Stabat Kabupaten Langkat, SMK Negeri 6 Medan, SMA YPK Medan, and MAN Lubuk Pakam Kabupaten Deli Serdang. Instrument of Collecting data used are questionnaires, observation guidelines, interview guides, students mathematics textbooks for 11th grade in SMA/MA, Teacher's guide book, instrument of pre-test and post-test. Development of model are adopted from Thiagarajan's model and Semmel & Semmel's model. This research has compiled teaching materials in the form of textbooks for 11th grade in SMA/MA and teacher's guide book that includes the structured steps of solving mathematical problems based on problem solving which can construct high-order thinking. Results of dissemination showed a significant improvement of students problem solving ability at four schools in three kabupaten/kota in North Sumatera.
Keywords: Learning Model, High-order thinking

A. Introduction

Observation result showed that Learning Model of Mathematics in SMA this time is not refer to specific learning theory yet. At the Learning process in the class, students was given ordinary problems that can be solved with simple analysis and mechanistic solution. Almost all of the learning process of mathematics in SMA beginning with shares of definition, formula, example, and ends with exercises. Occasionally be found, The proof of mathematical problems are solved by using an figure or a simple sketch. This condition was not able to improve the creativity and critical thinking of students. Moreover in learning at the class, Students are not accustomed to thinking axiomatic deductive, also students are not supported by their mathematics textbooks that are used. Most of the learning process of mathematics in SMA, lead students to memorize, solving mathematical problems ordinarily and a simple analyze inductively by following existing examples. Ironically, Teacher teach students by following monotonous method that are given in mathematics textbooks without considering student's cognitive improvement level. Whereas, learning mathematics require innovation and creativity of teachers and students. Due to it, Sumarmo (2005) state that student's problem solving ability is still low.

In the Curriculum 2013, The learning are using scientific method, multi-strategy, multimedia, adequate learning source and technology, and utilizing the environment as a learning resource. Learning Model that used is problem based learning. This model is appropriate to improve student's mathematical problem solving ability. In the learning process, student's activity are started with observation, then asking questions, trying, making network, and analyzing. Therefore now and future, We need learning model that should be able to improve student's mathematical problem solving ability in SMA/MA

B. Method

This Study is kind of the development research. The stages of learning model follow the procedure of Thiagarajan model and Semmel & Semmel (1974) models. According to Thiagarajan and Semmel & Semmel (1974), Development model that used is refers to *four D-Model*. Where consist of 4 steps namely *define*, *design*, *develop*, and *disseminate*. Results of development are described as follows:

Stage 1: Define

The purpose of this stage are set and defining learning activity by conducting analysis purpose and material limitations. In the stage of *Define* , will be desribed five activity that must be done namely: *ujung-depan analysis* (analysis Mathematics curriculum of SMA), Students analysis, concept and material analysis, assigment and formulation of learning purpose. Stage of define are described as follows:

a. *Ujung-Depan Analysis*
Purpose of this analysis is to analyze the basic problem that encountered in the development of learning model. Several things to note in *Ujung-Depan Analysis* are curriculum of 2013 and learning theory of Problem Based Learning.

b. *Students Analysis*

This analysis is done by observing the characteristics, ability and initial knowledge of students both as individuals and groups. In this analysis also seen the student characteristic in accordance with the design and development of teaching material. These characteristics consist of ability and background, experience, attitudes toward learning topics, media selection, the selection of format, language used and the cognitive development of students.

c. *Concept and material Analysis*
This analysis intended to identify, specify, compile systematically relevant material. The material will be developed then tested and taught by problem-based learning based on the *ujung-depan* analysis.

d. *Assignment Analysis*
This analysis intended to identify skills of students that are needed in mathematics curriculum in SMA based on curriculum 2013 and analyze it to a sub frame of skill.

e. *Formulation of learning purpose*
This analysis intended to convert the purpose of the assignment analysis and concepts analysis into specific learning objectives that expressed by the behavior of students in learning.

Stage 2: Design

This stage are purposed to design the learning model and supporting instrument that consist of Students mathematics textbooks of 11th grade in SMA/MA based on Problem Based Learning and Teacher's guide book. Result of *design* is called **Draft-1.** The activity of this stage consist of identify indicator of learning objectives and basic competence, define Problem based learning as the basis of Learning model of mathematics, initial design of mathematics book-manuscript of 11th grade in SMA/MA , and drafting the mathematics book-manuscript of 11th grade in SMA/MA.

Stage 3: Develop

At this stage there are four activities, namely:

a. Validation

Stage of *develop,* started with validation by expert then validation are conducted to the instrument of students textbook and teacher's guide book where it is designed in the stage 2(Draft I). Validation are conducted to content teaching material, language and format that is used. Validation are conducted by expert of mathematics in Senior high school, expert of indonesia literature, and expert of learning theory of mathematics for school. Aspects that are observed namely: whether steps scientific approach (observe, ask, try, associate and communicate) has been qualified on students textbooks and teacher's guide book , whether subject matter is arranged in a hierarchical (ordered according preconditions material), whether sentence in the students textbook and teachers guide book are easy to understand, whether sentence in the text is not ambiguous, whether display and content of the textbook interesting, whether the questions varied, whether the questions are presented contextually, whether sentences in questions are not ambiguous.

b. Revise

After experts provide the results of the assessment, Team revised the tools and instruments. Suggestions of experts is used to completion the mathematics book-manuscript of 11th grade in SMA/MA and teacher's guide book. Result of Revised students book-manuscript and teacher's guide book at this stage is called revision-I.

c. Trials

After doing revision-1 for students book-manuscript, teacher's guide book, and other instrument, The next activity doing trials on a limited basis. The trial is called as limited because of its dependence on the schedule of learning materials in schools where tested. So not all the material in students book-manuscript can be tested. Trials was conducted in four school in 3 kota/kabupaten in North Sumatera namely; SMA Swasta Yapim Taruna Stabat Kabupaten Langkat, SMK Negeri 6 kota Medan, SMA YPK kota Medan, and MAN Lubuk Pakam Kabupaten Deli Serdang. The Aspect that was observed in this trials are whether sentences in student textbook are easy to understand, whether sentence in the book does not have a double meaning, whether display and content of the book interesting, whether the questions in student textbook varies, and whether question in student textbook is easy to understand. In addition, the processes and activities of the students also studied during the implementation of the trial took place. Aspects are observed consist of; whether students are actively observing the learning material in each study group, whether students are actively asked in a group study, whether students are actively trying to solve the problems given in the textbook, whether students can connect information obtained from a given problem according to their way , whether students communicate the results of his thoughts with his friend whether students doing activities that are not related to ongoing learning, whether teachers arrange study groups at the beginning of learning, whether teachers give scaffolding, whether teachers give appropriate answers students questions, whether teachers instruct students to observe, ask, try, associate and communicate.

d. 2nd Revise

After Trials has been done, team revisions to content of students book-manuscript and tacher's guide book and other istrument. The Revisions are based on invention of trial result. Refinement have been done on Formatting,

Grammar of Indonesia Language in sentence (so contains no more sense) and graphs or pictures (so has a meaning that can be understood by students).

Stage 4: Dissemination of Learning model based on Problem solving

In this stage, there is only one activity. That is Validation trials. For the process of learning in the class, instruments that used are textbook-manuscript of 11th grade in SMA/MA ,Teacher's guide book and other instruments. While, Learning model that implemented is based on problem solving that used textbook-manuscript of 11th grade in SMA/MA and Teacher's guide book. This Activity was conducted in SMA Swasta Yapim Taruna Stabat Kabupaten Langkat, SMK Negeri 6 Medan, SMA YPK Medan, and MAN Lubuk Pakam Kabupaten Deli Serdang.

Details of each stage of development is given in Figure 1, 2, 3, dan 4.

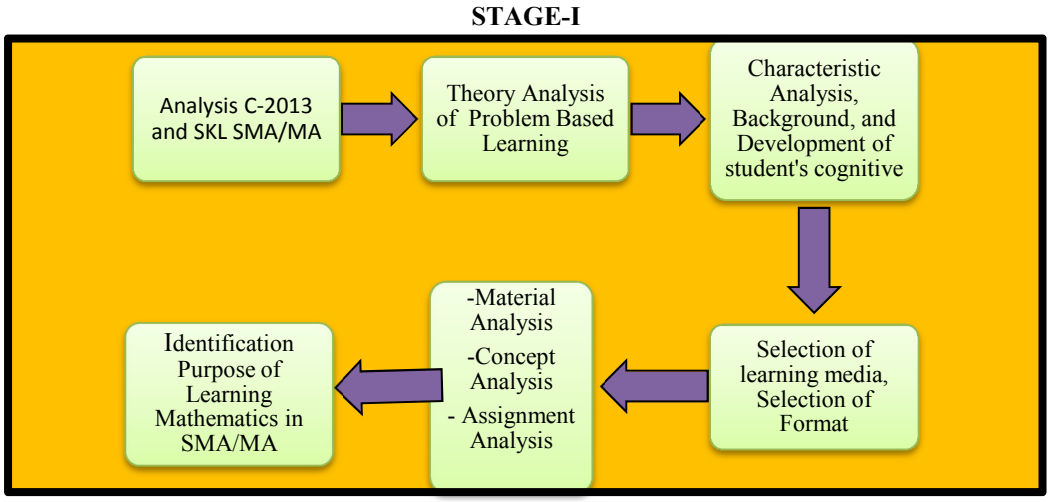

Figure 1. Stage of *Definition* and make the identification purpose of learning

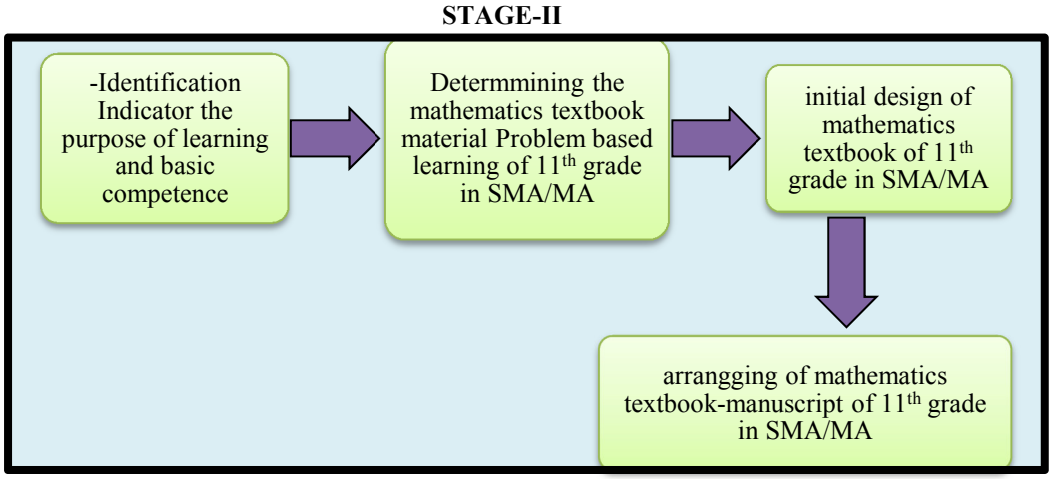

Figure 2. Stage of identification of Indicator, determining the textbook material, and Initial Design

STAGE-III

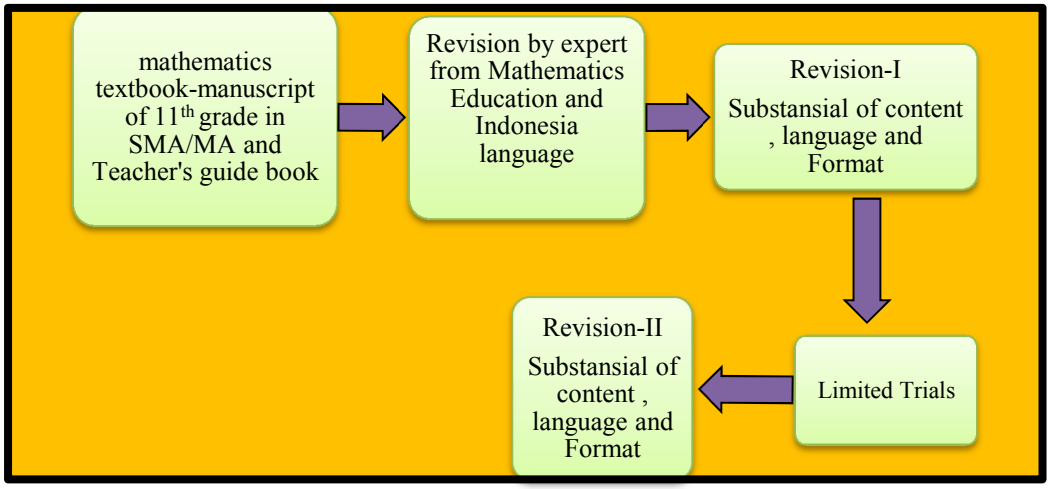

Figure 3. Stage of Revision, Revision-I, Trials, and Revision-II

STAGE -IV

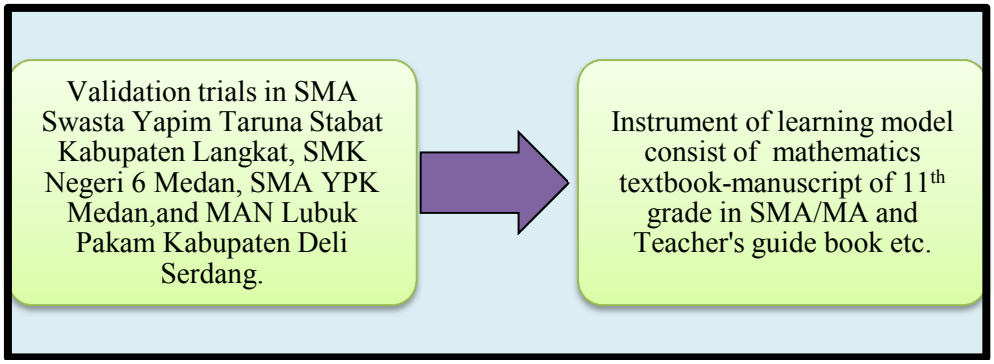

Figure 4. Stage of Dissemination (Validation trials) of learning model

Figure 5 Shows the fishbone diagram that illustrates the development process of learning model and Achievement targets.

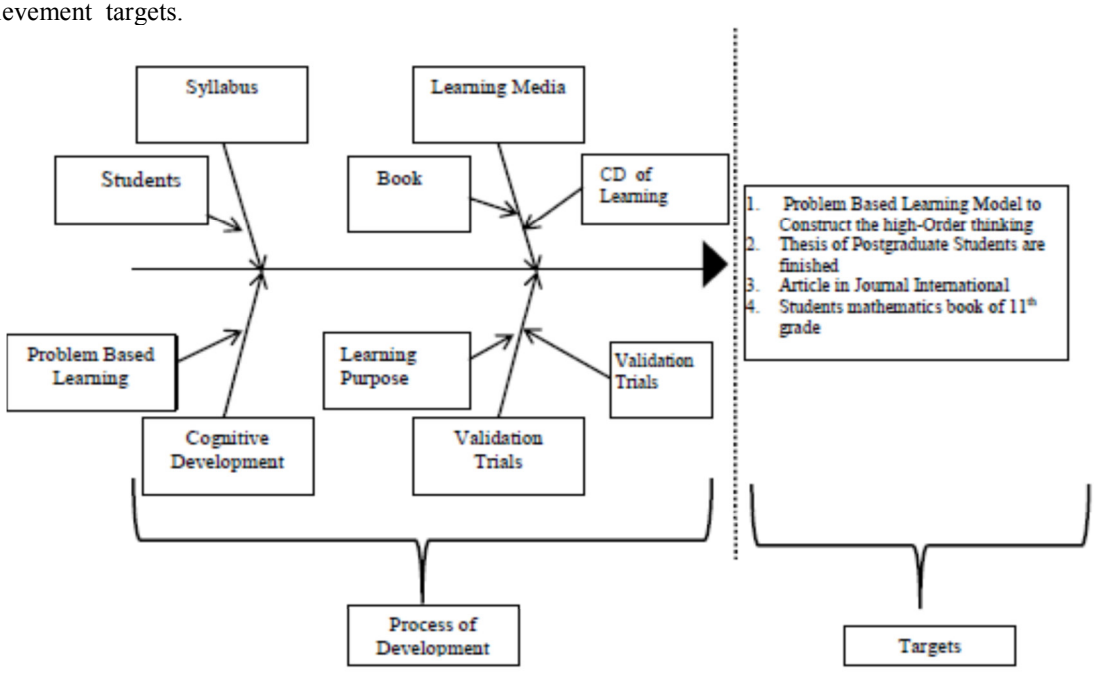

Figure 5: *Fishbone* Diagram

C. Result and Discussion

a. Result of study

Results of this research consist of learning models and supporting instruments which are; one package of mathematics learning instrument of 11th grade in SMA/MA, questionnaires, observation guidelines, interview guides, students mathematics textbook of 11th grade in SMA/MA, teacher's guide book, and instrument of pre-test and post-test.

Based on trials on four schools in three kota/kabupaten obtained the following results: as 33 from 37 students (89%) of 11th grade students in SMK Negeri 6 Medan said that the sentence in the book is easy to understand. 25 students (68%) said that the sentence in the book does not have a double meaning. as 34 students (92%) said that the display contents of the book interesting , and as 31 students (84%) said that the problems in the book vary. As more important, there are 22 students (59%) said that the sentence in the problem is easy to understand. In SMA Swasta YAPIM Stabat, 25 from 41 students (61%) of 11th grade said that the sentence in the book is easy to understand. As 27 students (66%) said that the sentence in the book does not have a double meaning. As 35 students (85%) said that the display contents of the book interesting , and as 39 students(95%) said that the problems in the book vary. While as 23 students (56%) said that the sentence in the problem is easy to understand.

In SMA YPK Medan as 32 from 37 students (86%) of 11th grade said that the sentence in the book is easy to understand. As 25 students (68%) said that the sentence in the book does not have a double meaning. As 21 students (57%) said that the display contents of the book interesting and as 34 students (92%) said that the problems in the book vary. While as 27 students (73%) said that the sentence in the problem is easy to understand. In MAN Lubuk Pakam there are 31 from 32 students (97%) of 11th grade said that the sentence in the book is easy to understand. As 30 students (94%) said that the sentence in the book does not have a double meaning. As 22 students (69%) said that the display contents of the book interesting, as 26 students (81%) said that the problems in the book vary. As 29 students (91%) said that the sentence in the problem is easy to understand.

In addition, there is a significant improvement of student's mathematical problem solving ability. It is proven by the differences in average of normalized gain between result of learning in Cycle-I and Cycle-II. The students average of N-Gain in Cycle-I is 0,312 and in Cycle-II is 0,441. After trials with t-test there are the significant improvement from both of result.

b. Discussion

From the test results that have been conducted, the learning activity is going well as expected. Students are actively observing learning material and asking in their study group. Students are actively trying solve the problem that are given. Student can connect the information that they got from the problem given. Students are actively communicating their opinion to their study group. Significantly, we can not see the students do things outside of learning. In the other side, research shows that teachers always arrange study group to form of 3 until 4 students in the beginning of learning. Teacher gives scaffolding, gives the correct answer based on student's questions and teacher always direct students to observe, ask, try, associate, and communicate the learning material with their aech study group. After that, Every group must present their work in front of the class. This phenomenon is consistent with results of research Muncarno (2001) which argues that learning using steps of problem solving can foster earnestness of students during the learning takes place, involvement in the learning process makes the class seem alive and excited to answer questions and solve the problems given by the teacher. In addition, research that done by Suwangsih (2004) inform that mathematics problem based learning using model Group Investigation Technique can improve student's learning outcome. Suwangsih's opinion is consistent with result of this study. In quantitatively there is significant improvement in student's mathematical problem solving ability from learning Cycle-I to next Cycle.

D. Conclusion and Suggestion

a. Conclusion

Concretely learning model can be implemented to improve students high-order thinking ability in solving mathematical problem. In addition, this study create the teaching material in the form of mathematics textbook of 11th grade in SMA/MA and teacher's guide book where is included the structured steps of mathematics problem solving to construct the high-level thinking. The result of trial shows a significant improvement of student mathematical problem solving ability.

b. Suggestion

Based on these results, the researchers recommended that the learning model and the entire instrument are applied in the mathematics learning for 11th grade in SMA/MA and SMK. The main instruments in this model are students textbook and teacher's guide book. Thus, students get used to construct high-order thinking in every mathematics learning.

E. References

Hasbullah, L. (2000). *Penerapan Model Pengajaran Pemecahan Masalah untuk Meningkatkan Hasil Belajar Matematika Siswa Madrasyah Aliyah*. Bandung: Tesis PPS-UPI Bandung

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

Muncarno. (2001). *Langkah-Langkah Pemecahan Masalah dalam Soal Cerita untuk Meningkatkan Prestasi Belajar Matematika Siswa Kelas VI SD*. Bandung: Tesis PPS-UPI Bandung

_____. (2008). *Penerapan Model Penyelesaian Soal Cerita dengan Langkah-Langkah Pemecahan Masalah Untuk Meningkatkan Prestasi Belajar Matematika Siswakelas 1 SMP*

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

Priatna, N. (2000). *Pengaruh Pembelajaran Matematika dengan Pendekatan Pemecahan Masalah Pada siswa SLTP*. Prosiding Seminar Nasional. Surabaya: FMIPA ITS.

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

Sudjimat, D. A. 2000. *Pembelajaran Pemecahan Masalah dalam Mata Pelajaran Matematika Sekolah Dasar. Suatu Studi Eksplorasi.* Malang: Disertasi PPS Universitas Negeri Malang.

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

Santyasa, I Wayan. (2004). *Model Problem Solving dan Reasoning adalah Sebagai Alternatif Pembelajaran Inovatif*. Makalah disajikan dalam Konvensi Nasional Pendidikan Indonesia di Surabaya.

Saptuju, (2005). *Meningkatkan Kemampuan Menyelesaikan Soal Cerita Siswa SMP melalui Belajar Kelompok Kecil dengan Pendekatan Problem Solving.*Bandung: Tesis UPI Bandung

Sukasno (2002). *Model Pembelajaran Pemecahan Masalah dalam Pembelajaran Trigonometri*. Bandung: Tesis PPS-UPI Bandung

Sutriningsih, N (2001). *Pembelajaran Kinestik pada Mata Pelajaran Matematika*. Surabaya: Tesis PPs-UNESA Surabaya

Suwangsih, E (2004). *Peningkatan Keterampilan Pemecahan Masalah Matematika Siswa Sekolah Dasar melalui Pembelajaran Kooperatif*. Bandung: Tesis PPS-UPI Bandung

Syahputra, E. (2011). *Peningkatan Kemampuan Spasial dan Disposisi Matematis Siswa SMP dengan Pendekatan PMRI pada Pembelajaran Geometri Berbantuan Komputer.* Bandung: Disertasi PPS-UPI Bandung

Syahputra. E., and Surya. E., (2014)., The Development of Problem Based Learning Model to Construct High Order Thinking Skill Students'on Mathematical Learning in SMA/MA. *Journal of Education and Practice*, ISSN 2222-1735 Vol. 5 no. 39, 2014

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