

Teachers' Simulation on Developing Problem Solving-Based  
Mathematics Textbook in Vocational Senior High School Mathematics  
Teaching in Indonesia

To be presented at  
*APEC- Ubon Ratchathani International Symposium 2011: Innovation on Problem  
Solving Based Mathematics Textbooks and E-textbooks*  
*Ubon Ratchathani, 2-5 November 2011*  
Thailand

By

Marsigit and R. Rosnawati  
Department of Mathematics Education, Faculty of Mathematics and Science,  
Yogyakarta State University Indonesia

# Teachers' Simulation on Developing Problem Solving-Based Mathematics Textbook in Vocational Senior High School Mathematics Teaching in Indonesia

By

**Marsigit and R. Rosnawati**

Department of Mathematics Education, Faculty of Mathematics and Science,  
Yogyakarta State University Indonesia

## ABSTRACT

Providing books or textbook is one of the crucial policies to improve the quality of teaching learning processes i.e. improving problem solving skills. The ideal program for providing the needs of the books containing problem solving approach should not in the means of monopoly by one or some institutions, but let the schools to choose their own needs of textbook to be used at schools. It was also to be suggested that the students have their right to select and by their own books without much intervention by the teacher or by the school. However, the situation is that it is still far away for the teachers to produce their own books. One of the reasons is lack of skill to write and produce good quality of textbooks i.e. the books that containing problem solving approach. However, there are fundamental problems for the teachers to develop such a book due to the understanding of the concepts of problem solving itself. This study strives to uncover teachers' perception on suggested textbooks, on the concepts of problem solving and how to implement them into the teaching learning of mathematics. The results of teachers' simulation lead directly to the competences and readiness to publish problem solving-based mathematics textbook.

**Key Word:** problem solving, mathematics textbook, vocational senior high school

## A. Introduction

The currently studies (Marsigit, 2010) on mathematics education in Indonesia have the indication that children's achievement in the subjects of mathematics and Science is low, as indicated by the result of the National Leaving Examination year by year both in Primary and Secondary School. Children's mastery on mathematics concepts and mathematics process skills is still low. This fact may be as the results of: (1) the shortage of laboratory activities; (2) lack of teachers having mastered science process skill approach; (3) contents on Mathematics and Science curriculum too crowded; (4) too many time consuming administration stipulation for teachers; (5) lack of laboratory equipment and laboratory human resource. The study also indicates that mismatch among the objectives education, curriculum, and evaluation system which can be identified by the following: (1) National Leaving Examination assess the children's

ability cognitively only; (2) Streaming in Senior Secondary School starting at grade 3; it is argued that the implementation of this system is late and consider individual differences inappropriately; (3) University Entrance Examination System is considered to trigger Elementary and Secondary School teachers apply goal oriented rather than process oriented in teaching Mathematics and Science, (4) many teachers still have difficulty in elaborating the syllabus, (5) a number of mathematics topics are considered to be difficult for teachers to teach; (6) a significant number of children consider some mathematics topics as difficult to understand, (7) teachers consider that they still need guidelines for conducting teaching process by using science process skills approach.

In our School-Based Curriculum, it was stated that mathematics in primary and secondary school should encourage the students to think logically, analytically, systematically, critically, creatively and be able to collaborate with others. The implementations of primary and secondary mathematics curriculum in class-rooms need to develop problem solving skills covering both closed and open problems. In solving the problems, students need to creatively develop many ways and alternatives, to develop mathematical models, and to estimate the results. Contextual and realistic approaches are recommended to be developed by the teachers to encourage mathematical thinking in primary schools. With these approaches, there is a hope that the students step-by-step learn and master mathematics enthusiastically. To make their teaching learning of primary mathematics more effective, teachers also need to develop resources such as information technology, teaching aids and other media.

The curriculum outlines the aims of teaching learning of mathematics are as follows: (1) to understand the concepts of mathematics, to explain the relationships among them and to apply them to solve the problems accurately and efficiently, (2) to develop thinking skills to learn patterns and characteristics of mathematics, to manipulate them in order to generalize, to proof and to explain ideas and mathematics propositions, (3) to develop problems solving skills which covers understanding the problems, outlining mathematical models, solving them and estimating the outcomes, (3) to communicate mathematics ideas using symbols, tables, diagrams and other media, and (4) to develop appreciations of the uses of mathematics in daily lives, curiosity, consideration, and willingness to learn mathematics as well as tough and self-confidence. Vocational Education prepares students for mastering a number of specific vocational skills.

These vocational skills are needed for employment. Vocational Senior High School offers three-year programs; these consist of about more than 40 subject lessons including Mathematics, which gives priority to expand specific occupational skills and emphasizes the preparation of students to enter the world of work and expanding their professional attitudes (Unesco, 2010)

## **B. Problem Solving Approach in Teaching Learning of Mathematics in Vocational Senior High School**

For a certain program of improving the quality of teaching learning mathematics in senior high school, research evidences indicated that it was take time for teachers to shift from teacher-centered to student-centered. Teachers developed teaching methods based upon more hands-on activities and daily life utilizing local materials. It needs time to encourage students to be active learner and involve in problem solving activities. Small group discussions were useful to share ideas on problem solving activities. To promote problem solving activities the teachers need to en-culture their efforts in innovating teaching learning processes which meet to academic students needs, encouraging students to be active learners, developing various strategic of teaching, developing various teaching materials, and developing teaching evaluation.

Specifically the teachers need to: plan the scenario of teaching, plan students activities, plan teachers' roles, distribute the assignments, develop assessment methods, and monitor the progress of students' achievements. By developing teaching materials teachers could encourage the students to do problem solving more efficiently. Students enjoyed their problem solving activities because they were involved in observing and doing things. The teachers perceived that in order to promote problem solving activities more effectively, they expected still to have a need: (1) to make good atmosphere for teaching and learning, (2) to promote to implement various teaching methods and teaching learning resources, (3) to give the chances for their students to perform their initiatives, (4) to promote cooperative learning, and (5) to support the students to be the active learner.

In the international perspectives, specifically Isoda Masami (2007) indicated that mathematical thinking has been described in the context of problem solving. For example, from the viewpoint of representation, the permanence of the equivalence of form is a way of extending mathematical form which is trying to keep the mathematical (or algebraic) structure. Representation is also a key window. He stated that in the problem solving approach for

mathematics teaching, the students meet an unknown problem which can be solved with previously learned mathematics. Students represent their own ideas, which they then discuss with each other. A solvable or approachable unknown problem for students is an important condition of problems in a lesson. Even if most of the mathematics problems that mathematicians encounter may take years to solve, they are solved based on what is already known.

Meanwhile, Polya (1957) outlined the steps of problem solving activities as follows: (1) Understand the problem, (2) Devising a plan, (3) Carrying out the plan, and (4) Looking back. He suggested that the students should have to understand the problem, to identify the unknown, to collect the data, to understand the condition. The students also need to know whether it is possible to satisfy the condition; whether the condition is sufficient to determine the unknown; whether it is insufficient or redundant, even may be contradictory. In devising the plan, the students need to find the connection between the data and the unknown. They may be obliged to consider auxiliary problems if an immediate connection cannot be found. They should develop a plan of the solution. When the students carrying out the plan of the solution, the teachers may check each step as well as examine the solution obtained. Polya and Pasmep (in Fajar Shadiq:2004:13) developed the strategies to problem solving activities as follows: (1) Trial and Error, (2) Making diagram, (3) Trying the simple problem, (4) Making Table, (5) Finding the pattern, (6) Breaking down the goal, (7) Considering the possibilities, (8) Thinking Logically , (9) Reversing the Order, and (10) Identifying the impossibility.

### **C. Textbooks-based Problem Solving in Vocational Senior High School Mathematics**

Thirty Vocational Senior High School Mathematics teachers from thirty different schools in the Province of Yogyakarta, have perception that good textbook for Vocational Senior High School mathematics should be understandable, meaningful, and contains of good examples. Most of them expressed that good textbook should use simple, communicative and standardized language. More than a half of them indicated that good textbook for Vocational Senior High School mathematics should be comprehensive in term of mathematical content and students' competencies (affective, psychomotor, and cognitive). Small number of them indicated that good textbook of mathematics should meet the following criteria: it should be systematic; it should be completed by good exercises; it should be completed by good assessment system; it should be

interesting in display, performance and good illustration and good layout; it should be relevant and applicable to daily life; it should be contextual textbook; it should be curriculum-based textbook; it should contain good problem solving; and it should promote active learners.

**1. Teachers’ Perception on Good Textbook for Vocational Senior High School Mathematics**

In relation with the supported textbook for problem solving approach, teachers’ perceptions consist of 12 (twelve) aspects as the following:

- a. It should motivate the students to learn mathematics
- b. It should develop students’ oriented teaching learning of mathematics
- c. It should support of achieving learning objective
- d. It should employ flexible teaching learning method
- e. It should facilitate students’ need to learn mathematics
- f. It should facilitate the students to do exercise mathematics
- g. It should dealing with the students’ difficulties in learning mathematics
- h. It should consist of summary
- i. It should as a communicative writing
- j. It should develop the cognitive schema of learning mathematics
- k. It should be as a students’ learning oriented
- l. It encourage the students to solve mathematics problems

**2. Teachers’ Perception on the Strategies of Problem Soling that can be developed in the Textbook for Vocational Senior High School Mathematics**

In relation with the strategies of problem solving that can be developed in the textbook, teachers’ perceptions consist of 10 aspects, as they were outlined by Polya:

<ul style="list-style-type: none"> <li>a. Trial and Error</li> <li>b. Make diagram</li> <li>c. Try for simple problem</li> <li>d. Make Table</li> <li>e. Find the pattern</li> </ul>	<ul style="list-style-type: none"> <li>f. Break down the goal</li> <li>g. Consider possibility</li> <li>h. Logical Thinking</li> <li>i. Reverse Order</li> <li>j. Identify impossibility</li> </ul>
--	---

### 3. Teachers' Simulation in Developing Textbook

Thirty mathematics teachers of Vocational Senior Secondary School simulated how to develop problem solving-based mathematics textbook. The activities were conducted as part of developing teaching learning resources in the Certification Program of the year 2011 at Faculty of Mathematics and Science, Yogyakarta State University. The supervisors, which were also the researchers, consisted of Dr Marsigit M.A and R. Rosnawati, M.Si. In order the teachers were to simulate the textbook production, the researcher developed and provided: (1) the questionnaire of teachers' perception about good mathematics textbook , (2) the questionnaire of teachers' perception about problems solving, (3) lecturing and whole-class discussion, (4) small group discussion, consisting of three teachers, to review and simulate the books, (5) published mathematics textbooks for Senior High School.

The procedure for the simulation consists of the steps as follows:

a. Whole-class Lecturing

In the whole-class lecturing, the researcher presented the theories of teaching learning process, developing curriculum and syllabi, developing teaching learning recourses, developing problem solving activities, and developing textbook. The presentation was supported by reviewing the models of teaching learning mathematics and plying some related videos. It was followed by question and answer activities.

b. Reviewing the Developed Text Books

The teachers got mathematics textbooks to be reviewed. The books were authorized by Dr Marsigit M.A., and they were published by Yudhistira Publication, 2008.

c. Small Group Discussion

In small group the teachers conducted the reviewing activities and discussed among the members of the group.

d. Teachers' Presentation

Some teachers presented their results of review and discussion in front of the class. They show and explain the models of problem solving activities and supported part of the books. It then followed by question and answer activities.

e. Whole-class Discussion

The researcher led the whole class discussion to get their conclusions or summaries.

f. Teachers' Filling in the Questionnaire

The questionnaires needed to be filled by the teachers consisted of teachers' perception of the criteria of good textbooks and suggested problem solving activities.

g. Teachers' Reflection

The teachers reflected their results of the review and wrote them following the criteria of the strategies of problem solving outlined by Polya (1957)

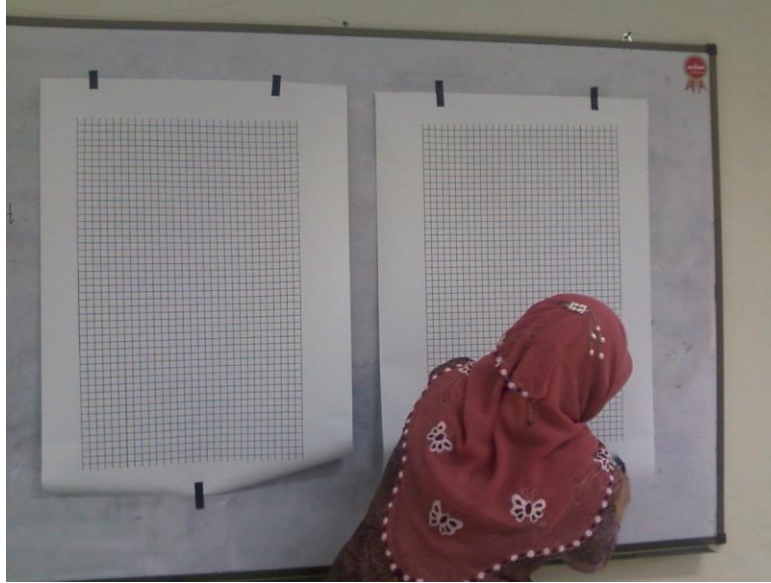


Picture 1: Mathematics Textbooks to be Reviewed



Picture 2: Teachers' Activities in Group Discussion





Picture 3: Teacher's Presentation of the Results of Discussion

## **D. The Results of Simulations and Discussion**

### **1. Simulation on the Criteria of Good Mathematics Textbook**

In order to motivate the students, the teachers perceived that mathematics textbook should have a good lay out, supporting references, clear cognitive scheme, clear applications of mathematics, examples of daily life, and history of mathematics. The teachers indicated that mathematics textbook should be based and oriented on students' learning activities; therefore, they suggested that it develop student's autonomous, mathematics drill, and problem solving. It is important that it also should be based on school-based curriculum. Further, such a textbook should support the students in achieving their competencies.

Relating to the needs for developing flexible teaching learning method, the teachers perceived that such a textbook should facilitate all students without any exceptionally. It should be used by the students both individually or collaboratively. Furthermore, it also should make the students feel confident and joyful. To make it happens the textbook should be arranged hierarchically and supported by on line internet resources. Step by step of finding the formulas may fulfill the students' need to learn mathematics. However, it is important to note that it provides various quiz and enough exercises and story problems. To make the students feel more confident it should contain answers for each problem.

It is realistic that every developed single book should deal with students' difficulties in learning mathematics. To overcome such condition, such a book should provide various ways to solve the problems. It was suggested that it provides such a space to get students feedback in order to communicate their ideas with their teacher. Therefore, the teachers though how to develop communicative textbook. The writer of textbook should consider how the students are able to understand the procedures. Short and not long sentences can be employed. The combination of good developed teaching content, curriculum based cognitive schema and the clear of the guidance make the students have their ability to develop their cognitive schema in learning mathematics.

The further crucial point of developing mathematics textbook is about its orientation. Presently, there is no further important point to be considered except that the textbook should be based on students learning activities. To meet this criteria such a textbook should employ realistic approach in which the students learn mathematics from the concrete daily life to get direct experiences and useful schema to prepare their activities in developing various model and mathematical procedures. However, there is still an ultimate question on how the textbook do encourage the students to solve mathematics problems? The teacher then recommended that such a textbook should provide: (1) trial and error schema, (2) activities of making diagrams, (3) activities of manipulating the tables, (4) finding the pattern, (5) breaking down the goal, and (6) considering possibilities.

## 2. The Criteria of Developed Problem Solving

The entirety of the simulation processes the teachers produced the criteria of the recommended problem solving activities should developed in the mathematics textbook, as follows:

### a. Trial and Error

<ul style="list-style-type: none"> <li>– It is useful to solve the problems</li> <li>– It is useful to get the best solution</li> <li>– It means of finding the method of solving the problems</li> <li>– It is useful to get the right answers</li> <li>– It should under the teacher's guidance</li> </ul>	<ul style="list-style-type: none"> <li>– It needs of manipulating concrete objects</li> <li>– It is useful to find the mathematics pattern</li> <li>– It is a speculative method</li> <li>– It is construct theories</li> <li>– It needs teaching aids</li> </ul>
--	---

<ul style="list-style-type: none"> <li>- It means of step by step solution</li> <li>- It is useful to learn any possibility of existing solution</li> <li>- It is useful to find the wrong answers</li> <li>- It is useful to identify the related concept (it needs pre-requisite)</li> </ul>	<ul style="list-style-type: none"> <li>- It involves drawing activities</li> <li>- It is useful for the teacher to motivate the students to solve mathematics problems</li> <li>- It is useful to find the formulas</li> <li>- It involves mathematical activities</li> <li>- It based on individual ways and experiences</li> </ul>
--	--

**b. Making diagram**

<ul style="list-style-type: none"> <li>- It is useful to record the data</li> <li>- It is useful to illustrate the situation</li> <li>- It is useful to get mathematical concepts</li> <li>- It is relevant to realistic mathematics</li> <li>- It is useful to illustrate the solutions of problems</li> <li>- It is useful to solve the problems easily</li> <li>- It is useful to show students' competencies</li> <li>- It employs various diagrams</li> <li>- It is useful to record experiment activities</li> <li>- It is useful to interpret the data easily</li> <li>- It is useful to communicate/share mathematical ideas</li> <li>- It is as a teaching media</li> </ul>	<ul style="list-style-type: none"> <li>- It is useful to relate two or more mathematical ideas</li> <li>- It is useful to organize possibilities</li> <li>- It is useful to produce summaries</li> <li>- It is useful to compare mathematical ideas</li> <li>- It is useful to classify the data</li> <li>- It is useful to visualize mathematics procedures</li> <li>- It is useful to make rough notes</li> <li>- It is useful to the prove the formula</li> <li>- It is useful to produce further diagrams</li> <li>- To make diagram is to solve the problems</li> <li>- It is useful to indicate the degree of achievement</li> </ul>
--	--

**c. Trying the simple problem**

<ul style="list-style-type: none"> <li>- It should from the simple problems to the complex one</li> <li>- It is useful to get prerequisite understanding</li> <li>- It is a mathematical method</li> <li>- It needs of applying the formula for the solution of the simple problems</li> <li>- It is useful to breakdown the complex problem into the simpler one</li> <li>- The simple problem should be taken from daily life</li> <li>- It is useful to evaluate the students' competencies</li> </ul>	<ul style="list-style-type: none"> <li>- It is useful to make mathematics concepts more realistic</li> <li>- It is useful to comprehend mathematics competencies</li> <li>- It is useful for the teacher to facilitate his/her students</li> <li>- It is useful to make the students understand about mathematical procedures</li> <li>- It needs to be supported by the use of teaching aids</li> <li>- Trying the simple problems need observation activities, recording, and conclusion</li> <li>- It is useful to make the abstract mathematics be more concrete one</li> </ul>
---	---

**d. Making Table**

<ul style="list-style-type: none"><li>- It needs to be supported by the using of teaching aids</li><li>- It is useful to summarize the data</li><li>- It is as a tool to solve the problems</li><li>- It needs students' skill to make the table</li></ul>	<ul style="list-style-type: none"><li>- It is as the method to solve the problems</li><li>- It needs students' skill to read the table</li><li>- It is closely related to experiment activities</li></ul>
--	---

**e. Finding the pattern**

<ul style="list-style-type: none"><li>- It is a continuing process from the previous step to the next step in order to solve the problems</li><li>- It should be supported by the use of Students Work Sheet</li><li>- It can be an individual activity</li><li>- It should lead to the finding of the formula</li><li>- It is the method to solve the problems</li><li>- It moves from the simple problems to the complex one</li><li>- It finds the rule</li><li>- It is the pattern of methods</li><li>- It is the pattern of problems</li><li>- It finds the relationship</li><li>- It finds the repeated procedures</li><li>- It leads to generalization</li></ul>	<ul style="list-style-type: none"><li>- Finding pattern is a natural way of life</li><li>- It is an abstract method</li><li>- It is relevant with experiment method</li><li>- It is repeated procedure</li><li>- It consists of possible other small patterns</li><li>- The students should find it</li><li>- The students can use one pattern to find other pattern</li><li>- The pattern makes mathematics be more meaningful</li><li>- It is more effective way to solve mathematics problems</li><li>- It consists of mathematical concepts</li><li>- The pattern is a repeated certain change</li><li>- It is useful to find the characteristics of mathematics problems</li></ul>
---	---

**f. Breaking down the goal**

<ul style="list-style-type: none"><li>- It means solving the problems step by step</li><li>- It means getting the different goals</li><li>- To solve multiple problems</li><li>- It is supported by the use of Teaching Aids and Students Work Sheet</li><li>- It means solving a big (general) problem through solving the smaller (specific) problems</li><li>- It means solving the longer term problem through solving the shorter term problems</li></ul>	<ul style="list-style-type: none"><li>- It means breaking down the procedures</li><li>- It means identifying the appropriate procedures</li><li>- It is useful get the shorter procedures</li><li>- It is useful to make priority of doing certain procedure</li><li>- It appropriates with small group discussion</li><li>- It means classifying the mathematics problems</li><li>- It means breaking down the problem into the unit problems</li></ul>
--	--

**g. Considering the possibilities**

<ul style="list-style-type: none"> <li>- It should be facilitated by the Students Work Sheet</li> <li>- The teachers need to uncover students' thinking</li> <li>- It is more related to experiment activities</li> <li>- It is the possibility of students' thinking</li> <li>- It is the possibility of students' different answers</li> <li>- It is useful to uncover the risks and benefit of any activity</li> <li>- The possibilities need to be recorded</li> <li>- It means of the flexibility of mathematical procedures</li> <li>- It means of the possibility of the existing solution</li> </ul>	<ul style="list-style-type: none"> <li>- It is useful to clarify the mathematics problems</li> <li>- It is useful to classify the mathematics problems</li> <li>- It is useful to anticipate the unpredicted solution</li> <li>- It is useful to predict the correct or wrong answers</li> <li>- It means of identifying all possibilities</li> <li>- It means of considering the possibilities to apply a certain procedure to a different problem</li> <li>- It is useful to examine the strong (more effective) or the weakness (less effective) of a certain procedure</li> <li>- It is useful to provides non-routine problems</li> <li>- It means the students' creativities</li> </ul>
--	---

**h. Thinking Logically**

<ul style="list-style-type: none"> <li>- It means <b>of</b> expressing logically</li> <li>- It is contextual</li> <li>- It is situational</li> <li>- It is about understanding</li> <li>- It is about logical based thinking</li> <li>- It is useful to think clearly</li> <li>- It is useful to think rigorously</li> <li>- It is useful to get prior experiences thinking</li> <li>- It is useful to think systematically</li> <li>- It is useful to think coherently</li> <li>- It is useful to think scientifically</li> </ul>	<ul style="list-style-type: none"> <li>- It is useful to think effectively</li> <li>- It is useful to think realistically</li> <li>- It is useful to think rationally</li> <li>- It is as an if-then thinking</li> <li>- It is useful to develop analyzed-based thinking</li> <li>- It is useful think contextually</li> <li>- It is useful to develop experienced-based thinking</li> <li>- It is useful to relate problems that has similar characteristics</li> </ul>
--	--

**i. Reversing the Order**

<ul style="list-style-type: none"> <li>- It is useful method to employ prerequisite understanding</li> <li>- It is useful method to produce the reasons</li> <li>- It is useful method to examine the results</li> <li>- It means reconstructing the mathematics procedures</li> <li>- It is useful to produce explanation</li> <li>- It is useful to review the methods</li> <li>- It is useful to reflects the process</li> </ul>	<ul style="list-style-type: none"> <li>- It is useful to learn different procedures</li> <li>- It is useful to examine the concepts</li> <li>- It is useful to relate some procedures</li> <li>- It means of predicting the results first then thinking the procedure later.</li> <li>- It means copying the procedures</li> </ul>
---	--

**j. Identifying the impossibility.**

<ul style="list-style-type: none"><li>– It is useful to learn why a certain procedure doesn't work</li><li>– It is useful to clarify why a certain procedure is work effectively</li><li>– It is useful for the teacher to observe his/her students works</li><li>– It is useful for the teacher to motivate his/her students to develop mathematical procedures</li></ul>	<ul style="list-style-type: none"><li>– It is useful to examine the teaching contents/teaching materials</li><li>– It is useful to find the new methods</li><li>– It makes the students to be more confident</li><li>– It is useful to solve the problems comprehensively</li><li>– It is useful to examine the procedures</li></ul>
--	--

**E. Conclusion**

The teachers delivered unstructured indications of the constraints for developing textbook for Vocational Senior High School mathematics. The most difficulties they feel to face if they should develop textbook for junior mathematics is about their lack of skill and knowledge of writing mathematical textbook. The others big problems are the difficulties in managing and allocating the time. They indicated others constraints as: it needs a budget; it is not easy to determine the theme of the book; it is not easy to collect supporting data; it is difficult to develop interesting and good illustration textbook; it is difficult to dig up the idea or concepts of textbook and its paradigm; it is not easy how to develop curriculum-based textbook; it is difficult to develop comprehensive textbook; and, it is not easy how to use simple, communicative and standardized language. Small of them indicated that they still have difficulties in developing thematic textbook; difficulties in developing textbook as students' guide to learn; difficulties in developing problem solving activities; difficulties in promoting students as active learner; as well as, it is not easy how to adapt psychological aspect of students learning mathematics e.g. students' motivation.

The efforts of developing textbook for Vocational Senior High School mathematics should always put the concern of the criteria of good textbook. Specifically, for the needs to develop textbook for junior mathematics we need to have a clear picture on how to plan and implement activities in the classroom the following: problem solving activities, reasoning and proof, mathematical communication, mathematical connections, mathematical representation, the role of technology, content arrangement and skills development, content appropriate and relevant, wide range of student interests and abilities, and materials easy to follow and

understand. In the case of developing the layout or design of textbook we may consider the following: the objectives given for each section; exercises and activities relevant to learning objectives; developing the relevant and useful graph, tables, charts, visuals; cross-curricular learning exhibited; clearly and appropriately defined some key terms; and reading level and language use appropriate to students. The problem solving based mathematics textbook in the Vocational Senior High School can be developed based on the criteria outlined by Polya and Pasmep that are: (1) Trial and Error, (2) Making diagram, (3) Trying the simple problem, (4) Making Table, (5) Finding the pattern, (6) Breaking down the goal, (7) Considering the possibilities, (8) Thinking Logically, (9) Reversing the Order, and (10) Identifying the impossibility.

## Reference :

- Borg, W.R., & Gall, M.D (1983) *Educational Research an Introduction*. New York: Longman
- Conaty, J.C, (1998) *The Educational System in Japan : Case Study Findings* : National Institute of Students Achievement, Curriculum and Assessment, Office of Educational Research and Improvement, USA.  
*Competent-Based Curriculum for Junior High School Mathematics in Yogyakarta*. Jakarta: Department of National Education
- Collins Educational Glenn, J, (2000) *A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century: Before It's Too Late*, Washington: The National Commission on Mathematics and Science.
- DGSE (2002). *Guideline of National Semiloka for Socialization the Development of*
- Ebbutt, S. and Straker, A. (1995) '*Children and Mathematics*', *Mathematics in Primary school, Part 1*, London,
- Isoda Masami, 2007, Progress Report of the APEC project: Collaborative Studies on Innovations for Teaching and Learning Mathematics in Different Cultures (II) - Lesson Study focusing on Mathematical Thinking -"
- Marsigit, (2000), *Improving the Quality of Primary Mathematics Teaching in Indonesia*, Journal of Japan Society of Mathematical Education Vol.7 May 2000
- Marsigit. (2003). *The Concept of Curriculum 2004 and Competent-Based Syllabus for Junior High School Mathematics. Paper: Presented at National Level of Training of Trainer (TOT) for Basic Science*, in Yogyakarta, 15-20 December 2003
- Mukminan dkk. (2002). *Pedoman Umum Pengembangan Silabus Berbasis Kompetensi Siswa Sekolah Lanjutan Tingkat Pertama (SLTP)*. Yogyakarta: Program Pascasarjana UNY.
- How To Solve It, by George Polya, 2nd ed., Princeton University Press, 1957, ISBN
- Fajar Shadiq.2004. Pemecahan masalah, Penalaran, dan Komunikasi, <http://fadjarp3g.wordpress.com/2007/10/09/what-research-says-about-mathematical-problem-solving>
- UNESCO, 2011, World Data on Education Données mondiales de l'éducation Datos Mundiales de Educación VII Ed. 2010/11