

# MATHEMATICAL MODELLING COMPETENCIES FOR HIGH SCHOOL STUDENTS

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## **MATHEMATICAL MODELLING COMPETENCIES FOR HIGH SCHOOL STUDENTS**

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### **Abstract**

Mathematical modeling is an important part of problem solving skill. Mathematical modeling can be taught and learnt. Mathematical modeling is a domain in Indonesian school mathematics curriculum. Mathematical modeling competencies are the essential part of mathematic learning. But mathematic literacy is essentially the ability to have a good mathematical modeling competency. In this paper, we studied about mathematical modelling through literature study.

**Key words:** mathematical modeling, competencies

### **INTRODUCTION**

Mathematics is the basis knowledge of all kind of scientific fields' development. The role of mathematics can not be separated from all aspects of life with its rapid development technology. Therefore mathematics becomes a tool in problem solving either directly or indirectly. Mathematics is taught in all schools in all countries since we can find this subject in every structure of the educational curriculum. Students learn Mathematics at school so that they can improve their problem solving skill through their ability to think analytically and systematically. When students learn Mathematics they have to complete certain competencies which later on also have a useful role to complete other competencies from different study.

Life demands us to be able to solve every problems and obstacles to gain better living. This is why students at school need to master what so called as problem solving skill. A strategic issue commonly uses mathematical concept in how to think logically, analytically as well as systematically.

In Content Standard Curriculum 2006 mentions that students learn Mathematics to develop students' ability to think logically, analytically, systematically, critically and creatively as well as their skill in performing teamwork. This book also clearly explains the goals of learning Mathematics are the following: 1). To comprehend the concept of Mathematics, be able to explain the correlation between concept and to implement the concept/algorithm promptly, efficiently, accurately, and precisely in solving problem. 2). to use reasoning/logical thinking about mathematical patterns and characteristics, to apply mathematic manipulation in generalizing, proving, or explaining ideas and mathematical statement. 3). to solve problem which involves skill to comprehend the problem, designing mathematical model, finishing the model and interpreting the solutions. 4). to communicate the ideas using symbols, tables, diagrams, or other media to clear up the condition or problem. 5). To appreciate the uses Mathematics in life, to possess curiosity, concern and interest in learning Mathematics as well as being tenacious and self confidence in problem solving. The third goal is to give explanation about competency in problem solving through mathematical model. This competency is similar to what has been decided at curriculum 2013. The same as curriculum 2006, in Content Standard Curriculum 2013 also mentions some competencies in problem solving which is using modeling concept.

From the explanation above, we can conclude that to achieve competency of problem solving, one of important supporting competency is the competency of Mathematical modeling. This article is result of literature study which is going to discuss about what so called as competency in mathematical modeling, how is the learning strategy which is using mathematical modeling, as well as the evaluation used.

### MATHEMATICAL MODELLING

According Sekerak (2010), mathematical modelling is a cognitive method where original object or situation is substituted by a model and by examining this model we gain the information we would gain by examining the original object or situation. In detail, the focus of mathematical modelling is a careful examination of all information presented in the problem and according to given information, building of mathematical (abstract) model in the way of mathematical, and logical relations and other presentations that authentically describe given situation. Modelling process can be divided into three phases: 1). identification of model situation starting points, 2). construction of a mathematical model, 3). verification of the built model.

Modelling process are a process that started with a problem, perhaps a real world everyday problem or a problem from another discipline. The modelling process continues with formulating the problem in mathematical terms and we get a mathematical problem. The mathematical problem can be solved by the application of mathematical concepts and solution processes. In this step, modeler need mathematic literacy and they have mathematical solution. Finally, the mathematical solution must be interpreted to provide an answer to the problem, and checked for its adequacy in answering the original question. A new cycle of formulation to improve the model may then begin. In the formulation stage, the problem solver faces a problem situated in a real context or science context, and then gradually trims away aspects of reality, recognizing underlying mathematical relations, organizing according to mathematical concepts, and describing the stripped down problem in mathematical terms. In the interpretation stage, the problem solver considers the mathematical result(s), and uncovers their meaning in terms of the real context. (Rafiepour, 2013).

Blum and Leiss (Ji, 2012) proposed a modelling process under cognitive prespective. The process described on figure 1.

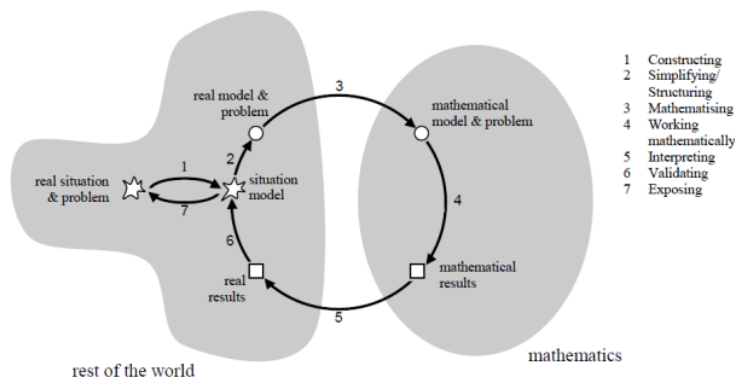


Figure 1. Modelling Process

Mathematical modelling is so important for student that's meant to help student's to better understand trough problem, and can support mathematics learning. By modelling, mathematics become more meaningful for learners. (Bluum,2009).

### MATHEMATICAL MODELLING COMPETENCIES

Based on Indonesian dictionary, competence is a ability. Competence is a complex knowledge, skills, and abilities. Maab (2006) said that modelling competencies include ability and skill to conduct modelling process adequately and ini goal-oriented way; as well as the willingness to put these abilities and skills into practices.

According Sekerak (2010), there are eighth competencies mathematical modeling 1). Focus on starting point of model situation, 2). Structuralize areas and situation that has to be modeled, 3).

Mathematization, 4). Produce mathematical model, 5). Prove the model from perspective of real situation, 6). Think, analyze, present the model (including its borders or limitations), 7) demathematization, 8). Track and control the process modeling.

Maab (2006) proposed competencies (table 1) that are related with modelling process based on theoretical Blum and Keiser :

Competency	Sub competency
Competencies to understand the real problem and to set up a model based on reality	<ul style="list-style-type: none"> <li>• to make assumptions for the problem and simplify the situation;</li> <li>• to recognize quantities that influence the situation, to name them and to identify key variables;</li> <li>• to construct relations between the variables;</li> <li>• to look for available information and to differentiate between relevant and irrelevant information;</li> </ul>
Competencies to set up a mathematical model from the real model	<ul style="list-style-type: none"> <li>• to mathematize relevant quantities and their relations</li> <li>• to simplify relevant quantities and their relations if necessary and to reduce their number and complexity;</li> <li>• to choose appropriate mathematical notations and to represent situations graphically;</li> </ul>
Competencies to solve mathematical questions within this mathematical model.	<ul style="list-style-type: none"> <li>• to use heuristic strategies such as division of the problem into part problems,</li> <li>• establishing relations to similar or analog problems, rephrasing the problem,</li> <li>• viewing the problem in a different form,</li> <li>• varying the quantities or the available data etc.;</li> <li>• to use mathematical knowledge to solve the problem;</li> </ul>
Competencies to interpret mathematical results in a real situation	<ul style="list-style-type: none"> <li>• to interpret mathematical results in extra-mathematical contexts;</li> <li>• to generalize solutions that were developed for a special situation;</li> <li>• to view solutions to a problem by using appropriate mathematical language and/or to communicate about the solutions;</li> </ul>
Competencies to validate the solution.	<ul style="list-style-type: none"> <li>• to critically check and reflect on found solutions;</li> </ul>

Table 1. Competencies and sub-competencies of Mathematical Modelling

### **MATHEMATICAL MODELLING APPROACH IN CLASSROOM**

Doosti (2009) give considered for the process of modelling in the classroom as follows:

- The teacher need to define and identify an suitable problem to be investigated;
- The teacher tries to determine the important factors or basic concept for his student.
- The teacher needs to represent those factors one by one and interplay them mathematically and write the mathematics relations and analyze them;
- The teacher need to interpret the mathematical results in the context of real world phenomenon;
- Evaluate how applicable the results are to the real world situations.

Doosti ( 2009) said in his finding research that there are advantages and disadvantages of mathematical modeling process in the classroom, among others the advantages are:



- The students are more interested in an activity such as mathematical modeling than learning the context, solving some problems, and learn how to solve an equation, without knowing how the problem can be applied in real world, since in general, the mathematics problems have no meaning for students, not even for teachers;
- The students learn how to make a connections to other situations, especially to the physical situations; in fact, the student will feel more prepared to the use of mathematics in other areas;
- The learning will have a real meaning; in other words, it becomes easy to make connections to other situations and problems; It is much easier for most students to remember a modeling problem that spent much time on than a mathematical equation;

He said there are disadvantages, among others: the choosing of good problem to discuss in the classroom is not very simple, in general, and in fact is the art of the teacher, the mathematical modeling process take more time than the traditional approaches; and students do not like to test a new approach, in general.

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