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Mathematical modeling worksheet using health context

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Abstract. The purpose of this study is to produce a valid mathematical modeling student worksheet. The method in this study uses the design research method with the type of development study. The research instrument developed was a mathematical modeling student worksheet. The subject of this study were 11th grade of senior high school student at Tebing Tinggi. The results of this study were a valid mathematical modeling student worksheet

1. Introduction

Mathematics as one of the mandatory subjects is expected to not only equip students with the ability to use calculations or formulas in working on test questions. Mathematics is also expected to be able to involve reasoning and analytical skills in solving everyday problems [1]. The quality of mathematics learning is based on increasing student literacy to understand the use of mathematics in daily life as a citizen who builds, cares and thinks [2]. Mathematical literacy is defined as the ability of a person to formulate, apply and interpret mathematics in various contexts, including the ability to do mathematical reasoning and use concepts, procedures and facts to describe, explain or predict phenomena/events [3].

The use of context can make it easier for students to recognize problems before solving them. Context functions so that problems can be solved and context supports the formation of space and transparency of problems and can give birth to various strategies [4]. There are four contexts related to students, namely personal, general, work and scientific contexts [5].

Students' thinking skills become the framework of their performance in identifying situations for conducting mathematics learning [6]. The difficulty in understanding Mathematics is because the object of Mathematics study is abstract mind objects. Indonesian students are only able to answer questions in the low category and very few or almost no one can answer questions that demand high-level thinking [7]. One approach that is relevant for students to understand abstract mathematical problems that represent real-world problems into mathematical forms and find solutions is mathematical modeling [8].

Mathematical context is defined as a situation drawn from a problem. The use of realistic contexts can involve students actively in exploring the problems encountered. Exploration aims to find answers to the problems given and to develop strategies for solving problems. Students need to understand the real world situation and make assumptions to design a mathematical method to overcome that problem. Thus, mathematical modeling deepens student understanding and enriches students learning mathematics [9]. Modeling is a powerful promoter of meaning and understanding in mathematics. When presented with problems arranged in a number of real-world contexts, students formulate questions about context and think about the usefulness of their mathematical knowledge to investigate questions. Students are encouraged to connect their mathematical knowledge with external contexts.



Mathematical thinking is promoted, and reasoning skills are carried out, as students try to make these connections [10]. When students work in groups to overcome those problems, they also develop important 21st century skills, such as collaborative learning skills and metacognitive skills [11].

Mathematical modeling is the process of translating between the real world and mathematics in two directions, so there are several reasons why mathematical modeling must be taught to students, namely building competency modeling, helping students to understand world phenomena, supporting mathematics learning in terms of motivation, concept formation and understanding and developing better mathematical competence [12]. The benefits of using mathematical modeling in learning is that it can help students to see mathematics as a source of production in their lives outside of school and in creating relationships that are appropriate for improving their mathematical abilities [13].

In several studies of mathematical modeling it turns out that getting maximum results in the use of mathematical modeling, among others, with the mathematical modeling approach affects the ability of students' argumentation to be better [14], other studies develop worksheets for mathematical modeling students to practice mathematical connection skills students [15], developing mathematical modeling questions students become active and have an interest in learning mathematics [16]. The application of mathematical modeling can improve basic mathematical abilities namely problem solving, reasoning and proof, communication, connections and representations [17, 18].

With modeling, mathematics education for students becomes more meaningful and justification of modeling is an important goal of teaching mathematics in schools [19]. Modeling serves to bridge the knowledge of non-formal mathematics and formal mathematics from students. Students develop these models by using mathematical models (formal and non-formal) so that students more easily solve contextual problems [20]. Mathematical modeling is an important aspect in mathematics education. In various countries, modeling ability is one of the focuses in classroom learning based on TIMSS and PISA evaluation results [21].

There are three levels of mathematical modeling, namely the first level of modeling recognition and understanding at this level is characterized by the ability to recognize and describe the process of modeling, characterizing, differentiating, and localizing in the modeling process. The second level is independent modeling, characterized by the ability to analyse and structure problems, abstract numbers, make different views, make mathematical models, solve models, interpret model results and statements, and validate models and whole processes. Students who have reached level 2 are able to solve problems independently even if the context or scope of the problem changes. The third level, namely the reflection on modeling, is characterized by the ability to critically analyze the model, formulate the evaluation criteria of the model, reflect the purpose of the modeling, and reflect on the application of mathematics [22].

Student worksheets abbreviated with learners worksheets are one part of the learning tool. The learning process requires learning tools as one of the important components developed by educators for students. The use of student worksheets will open the opportunity for students to be active and creative in the learning process. The purpose of the student worksheets is to facilitate the teacher in carrying out learning in addition to that students will learn independently, understand and carry out an assignment in writing [23].

In completing mathematical modeling worksheets, the process of solving mathematical modeling problems is identifying problems, making assumptions and identifying variables, doing mathematics, analysing and evaluating solutions, evaluating and applying models [24]. Therefore in this study the researchers wanted to develop teaching materials which are one of the sources of student learning in the form of valid mathematical modeling LKPD.

2. Method

This research is a design research that uses the type of development study. In this study aims to produce worksheets for mathematical modeling students in valid high school class XI. This research was conducted in odd semester 2019/2020. The research subjects were students of Senior high school number 3 at Tebing Tinggi class XI IPS 1.

This research was conducted in two stages, namely the preliminary stage (preparation stage and design stage) and the formative evaluation stage (expert review stage, one -to-one, small group, and field test) [25].

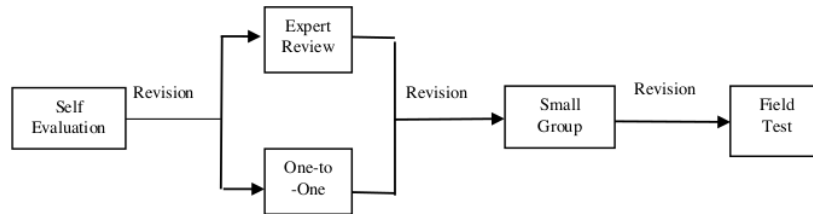


Figure 1. Formative evaluation stages.

Figure 1 shows that the procedure for developing mathematical modeling worksheets in this study uses several procedures in accordance with the steps in the chart above. The stages of formative evaluation in this study include preliminary and formative evaluation. At the preliminary stage including the stages of analysis, completion and development. In the formative evaluation stage which is in the form of the prototyping stage including self-evaluation, expert review, one to one which produces a student prototype modeling mathematical worksheets.

3. Result and Discussion

This research was conducted in two stages, the first stage consisted of preparation and design and the second stage was formative evaluation consisting of self-evaluation, expert reviews, one-to-one, small groups and field tests. In this study, at the preliminary stage which is the initial stage of developing mathematical modeling worksheets, researchers examined various literatures about developing relevant mathematical modeling worksheets in this study.

The researcher also conducted an analysis of the curriculum, where the curriculum used was the 2013 curriculum for the high school level. The researcher also collaborates with the subject teachers at the school where the research will be conducted in relation to the level of understanding ability of students who are classified as high, medium and low ability

Researchers also conducted an analysis of students aimed at seeing the initial abilities of students by giving pre-test questions. The questions given consisted of two questions conducted by 3 high, medium and low ability students.

JAWABAN

$$\begin{array}{l} 5x + 15y = 50 \\ 5x + 15y = 50 \\ 5x = 50 - 15y \\ x = \frac{95}{5} \\ = 19 \end{array}$$

$$\begin{array}{l} 10x + 5y = 40 \\ 10x + 5y = 40 \\ 5x = 40 - 15 \\ x = \frac{25}{5} \\ = 5 \end{array}$$

$$\begin{array}{l} 15x + 2y = 60 \\ 15x + 2y = 60 \\ 15x = 60 - 2 \\ x = \frac{50}{15} \\ = 59 \end{array}$$

Jadi Pengeluaran minimumnya adalah 400000.000 dan Lemak c.
Steak Minimum 2 dan Bawang Minimum 3

Figure 2. Student answers to the first problem.

In Figure 2 shows that in problem 1 students with high ability can determine the variables and determine the variables of the questions given but students have not been able to determine the

purpose of the problem being asked. Students with ability are being found that students cannot define and determine the variables requested by the problem and cannot understand the problems requested by the problems, students with low ability are found to determine the variables but cannot yet define the variables and students cannot understand the problem being asked.

JAWABAN

Dik. - Takaran Beras A = 5 kg / Rp. 1000
 3 kg / Rp. 1000
 Takaran Beras B = 10 kg / Rp. 1000
 1 kg / Rp. 1000

Mengapa Beras 1 = Rp. 1000 / 5 kg
 Beras 2 = Rp. 1000 / 1 kg

Dit. - Berapa takaran Beras A dan B?

Diketahui: $5x + 3y = 4000$ (1)
 $10x + 3y = 6000$ (2)

$5x + 3y = 4000$ | 1 |
 $10x + 3y = 6000$ | 2 |
 $-5x = -2000$
 $x = 400$

$5(400) + 3y = 4000$
 $2000 + 3y = 4000$
 $3y = 2000$
 $y = 666,67$

Takaran 1 = 400 (kg)
 2 = 666,67 (kg)
 $T_2 - T_1 = 666,67 - 400$
 $= 266,67$

Jadi, Beras A dan B adalah 400 kg dan 666,67 kg

Figure 3. student answers to the second problem.

In Figure 3 shows that in problem 2 students with high ability are able to determine variables and define variables but have not been able to understand the problem requested by the problem, in students with medium and low abilities have not been able to determine and determine the variable requested in given the problem.

From the analysis of the students' initial abilities, it was found that students have not been able to solve problems in daily life. From this preliminary analysis the researchers designed a mathematical modeling worksheet to understand abstract mathematical problems that represent real-world problems into mathematical form and find solutions. The focus of this research is to develop a mathematical modeling worksheet for students using the health context for class XI high school students. The characteristics of the mathematical modeling worksheets developed include the following descriptors.

Table 1. Indicators and descriptors of mathematical modeling student worksheets.

Indicator	Descriptor
Identify and understand the problem	Students can write information that is known Students can understand the problem Students can write information that is not yet known
Make assumptions	Students can make assumptions in the problem
Define variables	Students can express information that is not yet known in the form of mathematical symbols
Perform mathematical calculations	Students can find mathematical models as solutions to problems
Analyze and assess	Students can analyze and assess the solutions obtained by solving examples of other similar problems by using the mathematical model obtained earlier
Iterate	Students recheck the steps in solving problems
Interpret the results	Students can implement models

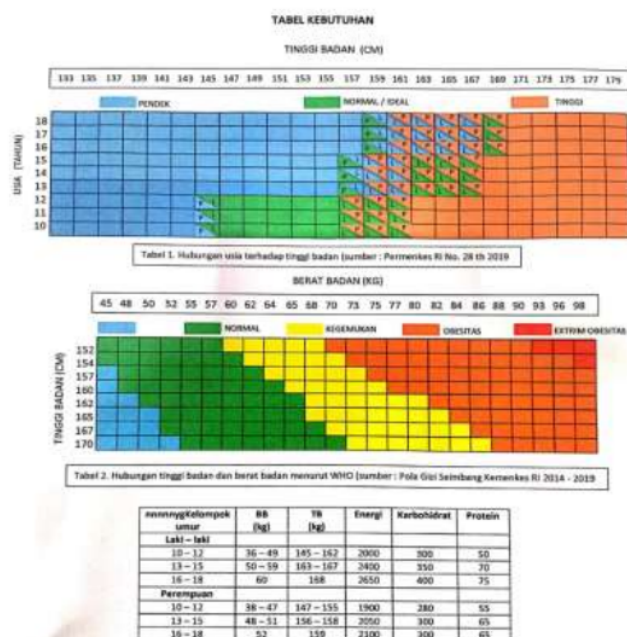


Figure 4. Mathematical modeling worksheets.

In Figure 4 shows that mathematical modeling worksheets are designed using completion steps in mathematical modeling where the developed student worksheets add an age factor which in previous studies used height and weight as a context of initial learning in the problem of normalizing body weight regarding the material to be teach.

Student worksheets were developed from previous research on the development of mathematical modeling questions [12], namely the development of mathematical modeling questions with health contexts using the problem of normalizing weight using height and weight as a starting point where researchers developed further by adding the age factor variable in development of mathematical modeling worksheets designed. In previous studies, research was conducted for elementary school students, here researchers developed a student worksheet for high school students. From the results of the pretest test given by researchers to some high school students, it was found that students could not model a problem that was asked for the problem, could not understand the problem given the problem, and students also could not define the problem in the form of mathematics. The researcher designs students' worksheets where in working on problems or solving problems, students are trained by using steps in the process of solving them so that students are more focused on solving problems as in previous studies. Besides that, the matter of mathematical modeling has a very good impact on students with a well-known health context and is experienced by students in their daily life regarding health issues about weight normalization, so students feel the benefits of mathematics in their lives.

4. Conclusion

Based on the results and discussion of this study, it can be concluded that based on the results of student pre-test analyzed by researchers so that researchers design mathematical modeling worksheets using steps in the process of completing mathematical modeling, namely identifying problems, making assumptions and identifying variables, doing mathematics, analysis and assessing solutions, evaluating

and applying models using the health context performance normalizing weight based on height and weight factors.

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