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On mathematical modelling task using health context for grade 5

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Abstract. This research aims to generate valid mathematical modelling task using health context for grade 5 in Auladi Integrated Islamic Elementary School, Palembang. To construct mathematical modeling task, ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model was used. The subjects of the research are students of CLASS V at Auladi Integrated Islamic Elementary School, Palembang. The data collection technique was performed by walkthrough, observation, and interview. The result of this research is valid and practical mathematical modeling task using health context.

1. Introduction

Mathematics has many benefits in life. Many sciences are developed from mathematics, such as physics and chemistry. Therefore, mathematics is known as the queen and servant of knowledge [1]. Another opinion stated that mathematics is a part of social reality [2]. Based on those opinions, in order to learn mathematics, students must relate it to the context of human life to make it easier to understand.

In TIMSS survey, conducted by International Association for the Evaluation and Educational Achievement (IAE), cognitive domain includes knowledge, implementation, and reasoning. Based on the result of TIMSS analysis in 2015 at grade 4, our students are still weak in the capability of a high order. Most of the students are not yet able to combine some facts and concepts and to apply and communicate the result of reasoning [3]. Meanwhile, a study of PISA, conducted every three years by the Organization for Economic Cooperation and Development (OECD), aims to investigate the literacy of mathematics in students. The focus of study of PISA is the capability of students in identifying, understanding, and using the basis of mathematics required in daily life. Indonesia participated in this study six times and constantly occupied the lowest position of all attending countries [4].

The essence of TIMSS and PISA study is in the mathematical reasoning of students and their capability in its implementation in daily life. It shows the weakness of students in relating the formal concepts of mathematics with the real problem, so it requires a tool to help them face the real problem.

The mathematical modelling can be used as a means of developing the mathematical problem in reality. The mathematical modelling has a considerable role in science and technology. The mathematical modelling is a process to change or represent real problems into a mathematical model as an effort to find a solution from the problem [5,6]. Meanwhile, another expert stated that mathematical modelling is a process which uses mathematics in representation, analysis, assumption, and giving insight about the real world [7].

Various researches have been done and have maximal result using Mathematical Modelling; students' competence in mathematical strategies, and their ability in problem solving and adaptive

reasoning. It shows that mathematical modelling was able to improve the mathematical modelling ability of students. However, it was focused on the learning process, whereas in terms of question sheets, the students are lack of understanding because of the inapt question. Therefore, the researchers would like to foster the questions in mathematical modelling toward the ability of mathematical modelling [8,9].

In the process for making problems of the mathematical modelling, there is a process to add meaning ~~or~~ which is commonly known as the process of providing context [7]. Therefore, this research discusses the personal context concerning health. This is helpful in socializing the program of balanced nutrition from the Ministry of Health. The principle of balanced nutrition has 4 (four) pillars which are basically a series of efforts to balance nutrient excretion and intake by monitoring the weight on a regular basis [10]. Thus, this research focuses on the problem in controlling the normal weight. It aims to inform students that mathematics has a role in the field of health.

Therefore, the researchers intend to develop the problems of mathematical modelling using health context in class V of elementary school. The formulation of this research is how the characteristic of valid mathematical modelling problem is and how the role of health context in learning mathematics is.

This research aims to generate the valid problems of mathematical modelling using the health context in Auladi Integrated Islamic Elementary School and the role of health context in understanding mathematics.

2. Methods

The research methods is ADDIE (Analysis, Design, Development, Implementation, and Evaluation) [11]. This research was conducted from March 18, 2018 to April 27, 2018 in Class V of Auladi Integrated Islamic Elementary School, Palembang. First, the analysis stage was conducted. It was an analysis on the needs and characteristics of students in class V of elementary school and on the curriculum. Based on the discussion between mathematics teacher and students, and the observation, the characteristics of elementary school students are as follows: (1) students prefer discussion with their friends in the learning process, (2) the curiosity of elementary school students on a new thing is considerable, (3) students cannot solve mathematical problems systematically, (4) students never get mathematical problems related to their daily life, and (5) students find difficulties in making the mathematical modelling to solve word problems since they cannot determine the right material to solve them. The curriculum used in class V of Auladi Integrated Islamic Elementary School was K13 that requires the suitability of core competence, basic competence, indicator, and purpose of learning.

Second, in the designing stage, the developed problem was about the mathematical modelling using health context. In the designing stage, the steps for solving the problems of mathematical modelling were adjusted to the steps in mathematical modelling [7]. The steps were identifying the problem, making assumption and identification of variable, conducting mathematical analysis, assessing solution, evaluating and applying the model. The stages in the form of a mathematicalmodelling problem used the health context with the modelling process [12] and MEA components [13] as follows:

a. New Paper Article

Figure 1 shows information which is helpful for solving problem about the tables of sport activities, IMT, food, and the conversion of calorie into kilogram.

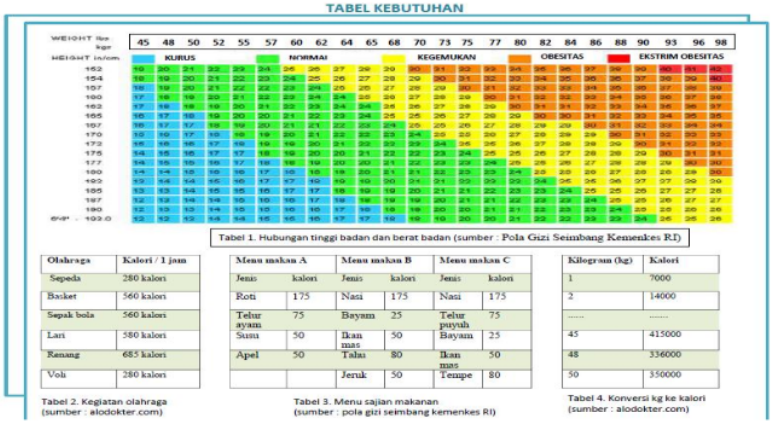

Figure 1. The designed table of needs has tables of IMT, sport with calorie, menu of food with calorie and conversion from kg to calorie.

Then, additional information was added in which Andri had to normalize his weight. Bicycling every day was his choice. Every day, Andri must eat menu b twice. (* 1 kg = 7,000 calorie).

In this process, there is a construction from the process of mathematical modelling in which students identify the existing problem in the article.

b. Warm up question

The questions are as follows:

1) What kind of information can be found in the text?
2) How much is the normal weight of Andri?
3) How long does Andri ride bicycle in one day (in hour)?

In this process, there was constructing and structuring from the process of mathematical modelling that students identify first. Then, assumption was made from the existing problem in article by directing it based on the questions.

c. Mathematical information

1) How many calories are burned by bicycling in one day?
2) How many calories are obtained from food in one day?

These questions direct students to perform the mathematical calculation based on assumption and identification of previous problem. Thus, in this process, working mathematically has been performed in the process of mathematical modelling.

d. Problem statement

How long does it take for Andri to normalize his weight? This question, which aims to know how he reduces his weight, is the real problem in the article.

In this process, students interpreted based on the obtained result. They then performed the validation to see the truth or suitability with the previously obtained information. After the students were sure about their problem solving, they exposed the result. A set of these questions is shown in Figure 2 below.

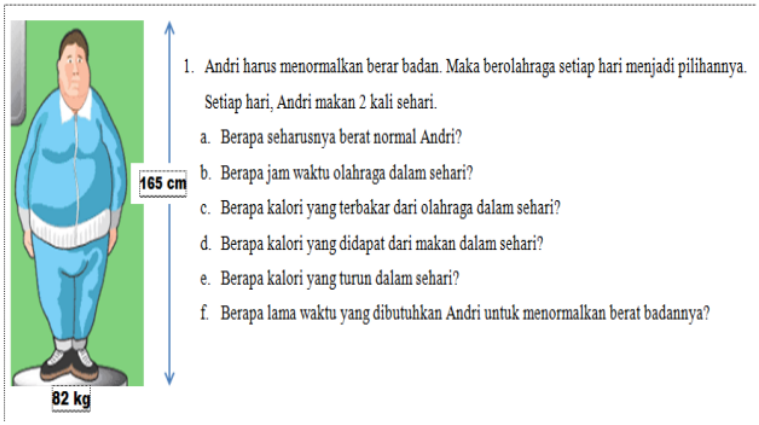

Figure 2. A set of these questions from the process of "Warm Up" question, mathematical information, and problem statement.

A result of the developed problem design is known as prototype I. After that, design validation was performed by an expert team. Expert review was performed for the assessment using walkthrough. The result of expert review aims to know whether or not the developed problem is valid in terms of content, construct, and language.

Third, in the development stage, small group and one-to-one stages were conducted. However, this research only discusses one-to-one stage that was chosen by three students with low, medium, and high capabilities. In this stage, data collection was conducted using observation and interview. One-to-one result focuses on the validity of developed problem. After reviewing the problem of mathematical modelling from the result of expert review and one-to-one, the revision was known as prototype II.

The last step in evaluation stage is a formative evaluation. The formative evaluation is an evaluation in the expert review and one-to-one stage. The used methods for data collection were walkthrough, observation, and interview. Formative evaluation aims to know whether or not the developed problem is valid [14,15].

3. Result

The results of this research are as follows:

3.1 Expert Review

The used validity in this research was qualitative validity. The validity of developed instrument was based on the assessment of experts who are relevant with mathematics, and their teaching and application of mathematics. The result of a study conducted by validator is summarized in Table 1.

3.2 One-to-one

In one-to-one stage, the developed problems were tested to three heterogeneous students. After the test, the students were asked about their opinion and suggestion on the given problems. It was intended to make the researchers able to observe the responses and obstacles faced by the students when facing the problems.

The one-to-one result is shown in table 2 regarding observation and settlement of students in solving problems as shown in Figure 3.

Table 1. The result of validation by expert review

Expert	Suggestion and comment	Decision of revision
Prof. Stevanus Budi Waluya	The problems are good. However, there are some sentences which must be simplified to avoid repetition.	Improving the recursive sentences
Dr. Gede Suweken, M.Sc	The problems are very good. However, the repeated questions or some questions with the same meaning need to be reduced. How much calorie is lost in one day? How much calorie is lost in the body in one day?	Improving the questions with multiple interpretation
Dr. Sitti R, M. Gizi	Table 1 is explained using WHO calculation table. The source needs to be clarified. Search the right sources from book or article.	Table 1 is improved based on the right source.
Ria Ariawati,S.Pd	Wrong sentences in the writing, for example, in the last sentence about the increase of weight. It asks about the weight which must be reduced. It should be about the weight which must be increased.	Revising the mistake in writing the intention of question

Table 2. The understanding of mathematical modelling in one-to-one stage

The understanding of mathematical modelling	Height	Intermediate	Low
identifying a problem	√	√	√
Making assumption and variable identification	√	√	√
Conducting mathematics	√	√	X
Analysis and assessing the solution	√	x	X
Evaluating	X	x	X
Applying model	X	x	X

In this stage, students still found difficulty in determining the content used for solving the real problem, using the health context, and relating calorie excretion and intake with the calorie which must be burned. Thus, in the next mathematical modelling stage, it was difficult for the students to perform well. It is shown in the answers of students in Figure 3 below.

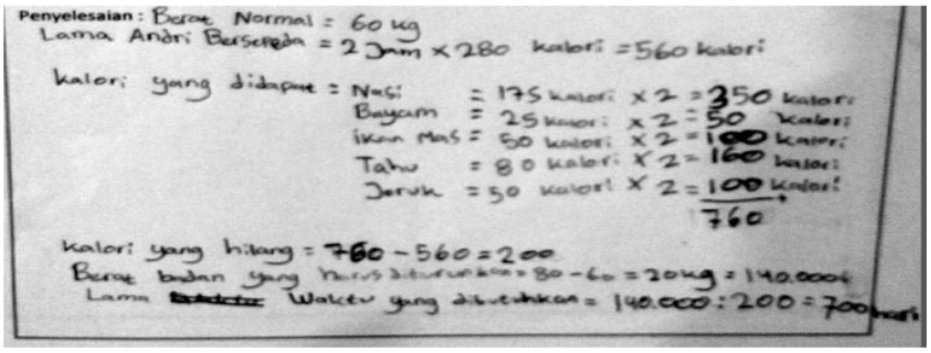

Figure 3. The answers of students in the one-to-one stage are suitable with the settlement of problem in the mathematical modeling.

From the answers of students, it is clear that the intake of calories (from food) is more than the calorie excretion (through exercise), so the weight of Andri keeps increasing. It is not in accordance with the right answer, in which the calories from food is lower than the calories burned through exercise. Meanwhile, the case is about how to normalize obese weight in the beginning. Thus, the result of revision from expert review and one-to-one is prototype II which is shown in Figures 4 and 5.

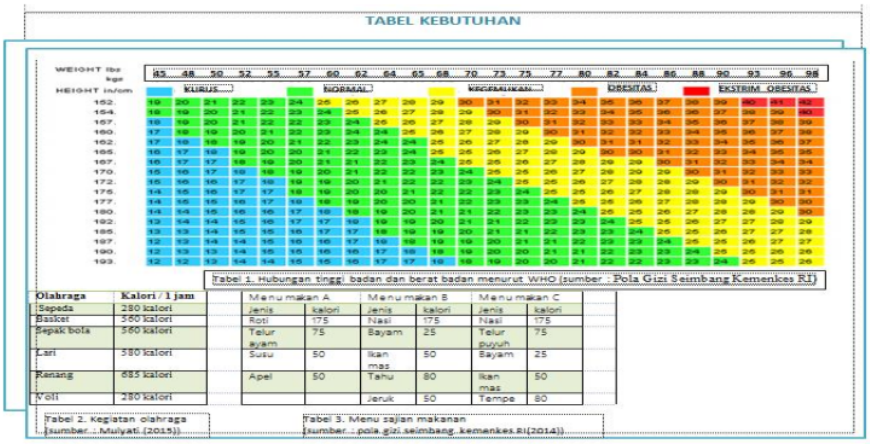

Figure 4. The improvement in writing the source of tables about exercise and relation between height and weight.

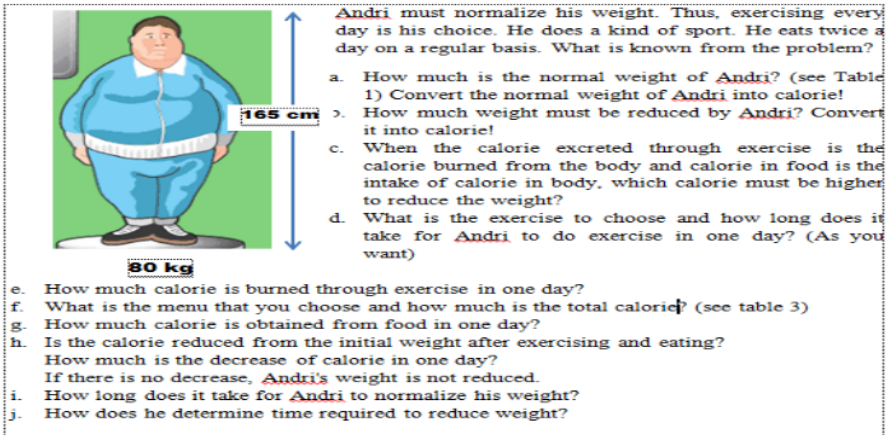

Figure 5. The problem of mathematical modelling in prototype II with additional questions to support the analysis of the relation about the calorie intake (from food) and excretion (through exercise)

4. Discussion

From the result of problem development process, the health context designed into a mathematical problem is suitable for mathematics in elementary school. Health is a very familiar aspect that is faced by every person. So, it can be a real problem which can be adapted into a mathematical model to find the solution. In the mathematical problem, it only uses the understanding about counting operation and integration of decimal number which have been learned in elementary school.

Evaluation from this stage was based on the comment and suggestion from experts, namely two lecturers, a doctor, and a teacher in Integrated Islamic Elementary School Palembang, comments from students, and drawbacks in the one-to-one stage which resulted in the valid problems. The validity of problems was based on content, construct, and language. In terms of the content, problems of mathematical modelling have been in accordance with the core competence from K-13 curriculum.

In terms of the construct, the problems of mathematical modelling have several characteristics, namely (1) problems of mathematical modelling use a highly familiar context which is experienced by every person in daily life, about health, (2) problems of mathematical modelling are started by considering table of relation between height and weight of body, table of sport and food to understand the problems (in this stage, students analyze what they know and are asked about the problems, so they focus on answering them), (3) questions in these problems help students to get assumption which is changed into variable to answer the problems, (4) answering the problems of mathematical modelling does not limit the students in mathematical process based on their capability or understanding. In terms of the language, the developed problems of mathematical modelling have used good and proper language which makes every student understand the information and questions in the problem.

By understanding *mathematical modelling,* students have been able to understand problems and make assumptions. It can be seen from the way the students determine the exercise time in a day, the desired food menu and the normal weight they want. Students have the ability to do mathematics although they do it in different ways according to the knowledge they have. This can be seen when they need to determine the calories of exercise that come out in a day. If the students consider 2 hours, the answer is 280students × 2 or 280 + 280. Doing mathematics that way is both true because it does not limit the students' ability to understand mathematics.

When analyzing and assessing solutions, students conclude the results of the answers. Meanwhile, at the evaluation stage students can evaluate verbally that if you are obese, you need to lose weight, with more exercise and reduce food intake or the vice versa. At the stage of applying the model, however, none of the students did it because students are not used to trying again with different assumptions. The following is a discussion of the abilities displayed by students when completing problems *mathematical modelling* using the health context which is shown in Figure 6.

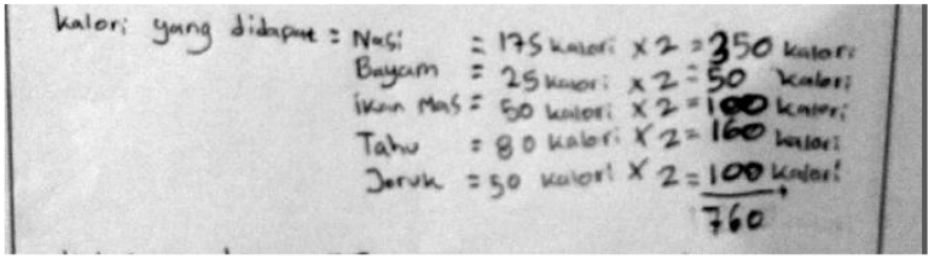

Figure 6. Students' answers to doing mathematics at the stage of mathematical modelling

In the process of doing mathematics, several students are slightly different in performing different processes. Those students multiply the meal calories by the meal frequency in a day first. Thus, they multiply 175 by 2, 25 by 2, 50 by 2, 80 by 2 and 50 by 2. The result of each multiplication is the addition operation which results in 760 calories. While most students do the meal calories first, then the multiplication operations.

Students have difficulty in applying the model to different cases, however. This can be seen from the results of the observations. This is because students do not usually work on *mathematical modelling* problems. Hence, it is expected to be applied so far in the learning process to familiarize students with solving real problems.

Based on the result of an interview with one of the students, the mathematical modelling problems make students interested to study, improve their capability to analyze, and help them understand mathematics using health context and make a mathematical model from the mathematical modelling problems using health context.

The result of interview between the researcher and the student is as follows:

Researcher: "*Fariz, what is your opinion about mathematical problems related to health?*"

Student : "*These problems are interesting since I never saw or solved them before. So, I want to know about my own health.*"

However, students feel that they still need the support from the teacher in answering some steps in these problems. From six steps in solving the problems of mathematical modelling, students find difficulties or obstacles in assumption stage since they are familiar with problems with one answer. Thus, students feel doubtful in making assumptionalthough their assumption is right. It allows the researchers to direct students in making assumption. The mistake in this stage will lead to another mistake in the third stage and so forth.

The result of observation also shows that students are interested in the problems of mathematical modelling using health context in normalizing weight. Students feel that they are beneficial in their life, so they are able to directly practice or share them with the people around them. Students solve the problems with their experience without limiting them in idealizing weight. Thus, the fear towards mathematics is not seen in students when solving the problems.

There are some drawbacks in the result of this research, such as a long time for students for solving the problems. The reason is that students are not familiar with problems which require them to analyze and evaluate. However, students are interested and motivated to solve the problems of mathematical modelling using health context since they experience the problems that affect their life.

5. Conclusion

This research results in the problems of mathematical modelling using health context in the valid category. The validity of problem is based on content, construct, and language. The problems of mathematical modelling using health context for class V elementary school have a role and benefits for students since they frequently experience the problems. Therefore, students are interested to learn mathematics and able to practice what they have learned in daily life.

6. Acknowledgements

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