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## Prospective teacher students' competencies in designing task on modelling based learning

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## Prospective teacher students' competencies in designing task on modelling based learning

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**Abstract.** This study aims to generate a clear and comprehensive description of prospective teacher students' competency in designing task on mathematical modelling. The subject is 24 prospective teacher students that are registered in mathematical modelling course. During the course, the researchers collected the data. The research is started from preparation stage that is analysis of mathematics study material, task design and validation of task by expert review. In the implementation phase, we do observation, interview, and field notes. The last stage of research is the analysis of data that has been collected. In this paper, we present some examples of mathematical task that was design by prospective teacher students. Furthermore, we highlight of prospective teachers' understanding as the result of interview. The first section in your paper

### 1. Introduction

Mathematical modeling is a process that uses the language of mathematics to represent real world phenomena, analyze the behavior to explore the understanding of the problem and make predictions to investigate and develop deeper understanding through an iterative problem solving [1]. These important things must be clear for teacher because teacher will translate it into the classroom activity in teaching and learning process. In the last two decades, the considerable research interest shown the mathematical modeling is constructed in the classroom, but the research of teacher competency in constructing mathematical modeling problem has attracted little attention and become limited research [2, 3, 4]. The reason might be sought in the difficulty to defining the step of developing mathematical modeling. To this direction, the present work, this is concerned to the way of transforming a mathematics problem into a modeling problem. The idea of transforming problem is started from adding the labels in math problem then adding the meaning in word problem. The last step is that adding interpretation in application problem. A modelling problem must give any opportunity for students to interpret the problem and force students to take ownership of some of the decision in the solution process.

Developing problem in mathematical modelling that engage students' interest gives teacher an ideal opportunity for integrating students' learning in classroom activity. Therefore, developing and selecting the good modelling problem is challenging especially for prospective teacher students who are new in the teaching and learning process.



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The framework for teachers' role in modelling consists of posing question, building solution and validating conclusions. Since modelling is an iterative process for students, supporting students' modelling is an iterative process for teachers [4].

## 2. Method

The research method in this study is descriptive qualitative. The qualitative descriptive research method is a research that describes the actual situation in the field. This study gives encouragement to the variables studied, then produces the conditions that are. This descriptive research theory of Newman's error analysis in exploring information in the form of Understanding (Understanding), Transformation (Transformation), Process Skill (Process Skill), and encoding (Encoding). The Newman's error analysis is a framework that considers the understandings occurred. This framework is used as a guideline to interview the prospective teacher students [5]. The interview prompts are :

1. Please read your problem
2. Show me the transforming of modeling problem in your designed task
3. Tell me the component of the modeling problem in your designed task
4. Explain to me the solution of your designed task

If the prospective teacher made a comprehension error, the researcher would make notes and explain the characteristic or component of modelling problem properly. This research has objects that was described, recorded, analysed and interpreted conditions that currently occur and are said by the research subject. The research subjects are the prospective teacher students who are students of Faculty Teacher and Training Education in Sriwijaya University. The total of subject research is 24 students. They followed the course of mathematical modelling for one semester. During this semester, students were trained to design the task based mathematical modelling. The research starts from preparation stage that is analysis of mathematics study material, task design and validation of task by expert review. In the implementation phase, we do observation, interview, and field notes. The last stage of research is the analysis of data that has been collected. The analysis of modelling task considered to the component of modelling process as a following figure 1.

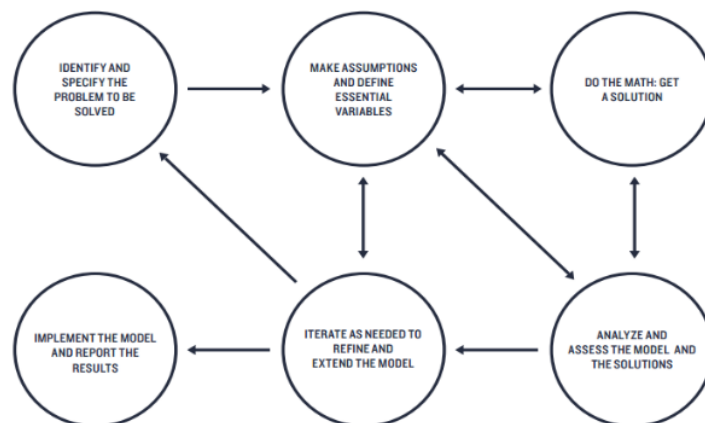


Figure 1. The Modelling Process [1]

### 3. Result and Discussion

There are 14 modeling task that were designed by prospective teacher students. They worked in pair. Once in a week at least 3 pairs presented their designed modeling task. Other prospective teacher students and lecturer gave some critics and comment on it. Here are some modeling problems that are designed by prospective teacher students:

#### Prototype 1

We will open a new restaurant. The restaurant offers the fried rice as a special menu. The recipe of the fried rice and its ingredients' price as a follow: (Rp. Means Rupiah)

- |                                  |                                   |
|----------------------------------|-----------------------------------|
| 1. Rice : 15 plates              | 10. Sausage : Rp. 29.000/40 pcs   |
| 2. Soya sauce :Rp. 15.000/bottle | 11. Meat ball : Rp. 95.000/100pcs |
| 3. Shallot :Rp. 45.000/kg        | 12. Salt : Rp. 2.000/sachet       |
| 4. Garlic :Rp. 35.000/kg         | 13. Chicken : Rp. 45.000/kg       |
| 5. Egg :Rp. 18.000/kg            | 14. Crackers : Rp. 7.500/250gr    |
| 6. Chili :Rp. 25.000/kg          | 15. Corned beef : Rp. 27.500/kg   |
| 7. Carrot :Rp. 15.000/kg         | 16. Oil :                         |
| 8. Cucumber : Rp. 6.000/kg       | - 1 litter : Rp. 12.000           |
| 9. Onion : Rp. 14.000/kg         | - 2 litter : Rp. 23.000           |
- The ingredients is for 15 plates of fried rice
  - a. Which are ingredient that is needed?
  - b. How much money do you need to buy the ingredient?
  - c. What is the best price to sell the fried rice?
  - d. If we can sell 15 plates of fried rice, do we get the profit?
  - e. If we get the profit, how much is it?

**Figure 2.** Example of modeling problem

In this task, prospective teacher students gave the information about the recipe of fried rice. It showed the ingredients of fried rice and its price. There are some questions based on the context of fried rice. The purpose of this task is counting the price of fried rice especially about profit and loss in social arithmetic. There are five scaffolding questions. The questions asked from the information of the problem until the profit or loss if you sell the fried rice. Based on the validating process by expert review, this first prototype problem is not the real problem for students. However, the characteristic of modeling problem is that question in the real world. By offering the real world problem, it can encourage students to solve the problem because they know the situation [1]. The problem is unrealistic to imagine a student as a fried rice seller asking for the solution to achieve best price of fried rice, getting the profit and loss in selling. The unrealistic problem can lead students to the error of making assumptions and identify variables. It occurred to this example 1. The assumption is so large and also the variables. Even the modeling problems ask students to answer in vary solution but as a teacher, we have to select the important real-world problem and identify relation between them [6]

#### Prototype 2

Ingredients of fried rice:

- |                           |                         |
|---------------------------|-------------------------|
| - 2 plates of rice        | - 3 leaves of lime      |
| - 4 cloves of shallot     | - 1 spoon of sugar      |
| - 3 cloves of onion       | - 2 spoon of oil        |
| - 3 chillies              | - 1 spoon of salt       |
| - 1 tomato                | - 1 spoon of pepper     |
| - 1 spoon of shrimp paste | - 4 spoon of soya sauce |

The ingredients is for 2 plates

Questions:

**Figure 3.** Example of modeling problem

According to the figure 6, the prospective teacher students attempted to revise their modeling problem by simplifying the ingredients of fried rice and deleting the price of it. This revision problem changes the learning topic from the previous prototype. This second prototype is about ratio. The given information of the problem is the ingredient for two people and the question ask about the proportion of the ingredient for six people and your family. Although this developing of modeling problem offers the fried rice context with the simple information, the task does not give student any chance to answer in larger question. The problem is still a closed problem that may not even come up with different models. Furthermore, it does not produce the assumption which is creating mathematical model. As such, it leads to a model as important of the actual results.

However, there are some good modeling problems that were designed by prospective teacher students. For instance, the modeling problem about the rate of taxi bike as below.

GRAB-BIKE	GO-JEK
MINIMUM RATE <b>Rp5.000,00</b>	TARIF MINIMUM -
📍 RATE per KM <b>Rp2.000,00/km</b>	📍 RATE FOR 1-2 KM <b>Rp4.000,00/km</b>
📍 RATE FOR MORE THAN 5 km <b>Rp2.500,00/km</b>	📍 RATE FOR MORE THAN 2 km <b>Rp1.500,00/km</b>
-----	
RATE FOR BUSY TIME MORNING 05.00-09.00 EVENING 16.00-20.00	RATE FOR BUSY TIME MORNING 06.00-09.00 EVENING 16.00-19.00
📍 EACH TRIP PLUS <b>Rp4.000,00</b>	📍 RATE FOR 1-2 KM <b>Rp4.000,00/km</b>
	📍 RATE FOR MORE THAN 2 km <b>Rp2.00,00/km</b>

**Which one is the best price from the rate taxi bike above?**

**Figure 4.** Example of modeling problem

The task above is the real problem about the rate in grab-bike and gojek. The task asked about the best price. According the different rate among grab-bike and gojek, it can generate different assumptions which lead to different solution. These different solutions show that this problem is an open-ended problem [7]. Therefore, this taxi-bike problem is suitable with the component of modeling process which start from identify the problem until implement the model and report the result.

Based on the result of the Newman's error analysis interview, the researcher listed up some conception of prospective teacher students that are realistic material, genuine problem and image situation. These conceptions influence the designed modeling task of prospective teacher students [8,9]. We generate two main topic of prospective teacher students' understanding in designing task. There are transforming problem and component mathematical modeling. It indicates that the diversity conception of pre-service teacher according to their experience in mathematical modeling problem [9,10,11]. In brief, the summary of interview to know the competency of prospective teacher students in designed task based on mathematical modeling can be seen the Table 1.



**Table 1.** The result of Newman’s error analysis interview

Topic	Prospective teachers’ understanding
1. Transforming problem	The differences between meaning in application problem and interpretation in modelling problem
2. Component mathematical modelling	<ul style="list-style-type: none"> <li>- Concerning the idea of real world problem</li> <li>- Identifying the assumption and variable</li> <li>- Clarifying the meaning of model and formula</li> </ul>

Some mistakes came up in developing problem based on modeling problem by prospective teacher students. In the first step of modeling process, identify the real problem, prospective teacher students still confused to select the appropriate the real world problem which has interpretation from the application problem. Teacher should consider how familiar students are with the contexts. Some questions might come up when creating the problem, such as what kind of question will students have about the context? Or does student any interest with the problem?. This interest problem will allow students to brainstorm initial ideas on how to approach the problem and to discuss mathematics models to solve the problem [12]. When, a modeling problem is found to be inappropriate, steps must be taken to revise it. For instance, prospective teacher students can change the content substantially or even replace it with the new context [13].

Next, students in solving the modeling problem start their work by taking the strategies, assumption, and variables. In constructing the modeling tasks, teachers should minimize the misconception of the problem [14]. Prospective teacher students have assumed in order to solve the problem and to make these choices. However, some prospective teacher students still have difficulty in giving open-ended nature of the tasks that can present a significant challenge. The solution of developing problem by them is still limited assumptions and models to solve the problem.

As students are getting closer to their final answers, teachers should support them to analyze their solutions and assess their models [15]. This step can include asking students to make sense of the solution in the context of the problem, to explore the vary ways in the accuracy of their solutions, or to think how their solutions change if they have different assumptions [16,17].

Overall, the core of thinking in designing the task on mathematical modelling is that considering the learning goals. These goals can be focused on how students engaged in mathematical modelling, how students make assumption to define the problem, the ways of students’ to choose mathematical tools to solve the problem, how students communicate their findings and explain it in order to make sense the answer [18,19,20].

#### 4. Conclusion

The misconceptions of the component from modeling process lead the pre-service teachers in constructing the modeling problem. Therefore, it is important to get the deeply discussion in understanding about it in the course of mathematical modeling. The important components of modeling process are identify the problem, make assumptions and identify variables, do the math, analyze and assess the solution, iterate, and implement the model. Modeling begins in a specific domain for example a phenomenon, task or process. Pre-service teacher face the challenge to expand and create become appropriate the modeling problem.

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