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DEVELOPING MATHEMATICAL MODELING TASKS USING PARKING FEE FOR LEARNING MATHEMATICS

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Abstrak: Tujuan penelitian ini adalah menghasilkan soal pemodelan matematika menggunakan biaya parkir yang valid untuk pembelajaran pemodelan matematika di SMK. Penelitian ini menggunakan pendekatan penelitian pengembangan oleh Akker, Gravemeijer, McKenney dan Nieveen. Penelitian ini terdiri dari 3 tahap, yaitu analisis, desain dan evaluasi. Langkah analisis dilakukan analisis siswa, kurikulum, kebutuhan vokasional, konteks yang dibutuhkan dan pemodelan matematika. Langkah kedua adalah desain dan produk. Langkah terakhir adalah desain evaluasi formatif yang terdiri dari evaluasi diri, one-to-one, experts review, small group, dan field test. Penelitian hanya melakukan evaluasi diri, one-to-one, dan expert review. Analisis data menggunakan deskriptif walk through, analisis komentar ahli, analisis solusi dan komentar siswa untuk mendapatkan soal pemodelan matematika konteks biaya parkir yang valid untuk pembelajaran matematika. Penelitian ini telah menghasilkan soal pemodelan matematika menggunakan konteks biaya parkir yang valid untuk pembelajaran matematika di SMK. Hasil penelitian ini menyarakan bahwa penting bagi guru untuk mendesain dan mengimplementasikan soal pemodelan matematika menggunakan konteks dunia nyata yang menarik dan bermakna dalam pembelajaran matematika, penelitian selanjutnya penting untuk memberikan scaffolding bagi siswa dalam soal pemodelan matematika untuk pembelajaran matematika, akhirnya, penelitian dan pembelajaran pemodelan matematika krusial untuk diterapkan ke depan.

Kata kunci : *Pembelajaran Matematika, Soal Pemodelan, Biaya Parkir*.

Abstract: The purpose of this study is to produce valid mathematical modeling tasks using parking fees for learning mathematical modeling in SMK. This study used a research development approach by Akker, Gravemeijer, McKenney and Nieveen. This research consists of 3 stages, namely analysis, design and evaluation. The analysis step was carried out by analyzing students, curriculum, vocational needs, context needed and mathematical modeling. The second step is design and product. The last step is a formative evaluation design which consists of self-evaluation, one-to-one, expert review, small group, and field test. The research only conducted self-evaluation, one-to-one, and expert review. Data analysis used descriptive walk through, expert commentary analysis, solution analysis and student comments to get a valid parking fee context mathematical modeling problem for learning mathematics. This research has produced mathematical modeling problems valid using the context of parking fees for mathematics learning in SMK. The results of this study suggest that it is important for teachers to design and implement mathematical modeling problems using interesting and meaningful real-world contexts in learning mathematics, further research is important to provide scaffolding for students in

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mathematical modeling problems for mathematics learning, finally, research and learning mathematical modeling crucial to be applied in the future.

Keywords: *Learning Mathematics, Modeling Tasks, Perking Fee.*

INTRODUCTION

The impact and implementation of learning mathematical modeling in everyday classes is still low (Blum, 2015, Riyanto, 2020). However, Gaston & Lawrence (2015) state that international research-based advice can support teachers' efforts to better understand, learn, teach, and evaluate related aspects of mathematical modeling and is needed to teach challenging mathematical modeling standards, and to help prepare students to meet the required qualifications that is demanding careers in science, technology, engineering and mathematics (STEM). In addition to facilitating educators to integrate mathematics into other STEM disciplines, mathematical modeling also gives more meaning to mathematics teaching and learning activities (Blum, 2015). Riyanto, et al. (2017, 2018, 2019) also show that students are interested to learning mathematics through mathematical modeling. Thus, learning mathematical modeling in everyday class is crucial/problematic.

Kieran, et al. (2015) states that Tasks/Problems play a crucial role in encouraging the process of improving the education system. This indicate that learning mathematics through modeling tasks is crucial for learning mathematics. In problem/tasks-driven classroom teaching methods, tasks are designed, measured, requirements (tested), appropriate learning environment and conditions, and this guides students to find the best way to solve problems (Wang, 2017). This show that teacher must use modeling task which was valid for learning mathematics. Modeling practice in the school context requires problems involving students in the modeling process and modeling problems are required to have an authentic, extra-mathematical character (Maass, et al., 2019). Therefore, modeling tasks have an important role for learning mathematics. Thus, researcher is interested in researching mathematics learning through modeling problems/tasks.

The Problem formulation in this study is how to Mathematical Modeling using parking fee contexts in vocational high school which is valid?. The purpose of this study was to produce valid mathematical modeling tasks using parking fee for learning mathematical modeling in SMK. The research is expected to provide benefits for teachers, schools, colleges and researchers as a guide for designing mathematical modeling learning in schools or colleges.

RESEARCH METHOD

This research applied the methods of design research with development research type that developed by Akker, Gravemeijer, McKenney and Nieveen. It consists of 3 phase, i.e, analysis, design and evaluation (Akker, et al., 2006). The first phase, analysis of student, curriculum, real-world problem, vocational needs, and mathematical modeling task characteristics were conducted. The second step, designed and produced of Mathematical Modeling Task using parkinmg fee contexts. The final step of this research implemented a design of formative assesment consisting of self-evaluation, one-to-one, expert review, small group, and field tests (Tessmer, 1993, & Zulkardi, 2006). Figure 1 describe formative assessment. This research was only conducted self-evaluation, expert review, and the one-to-one.

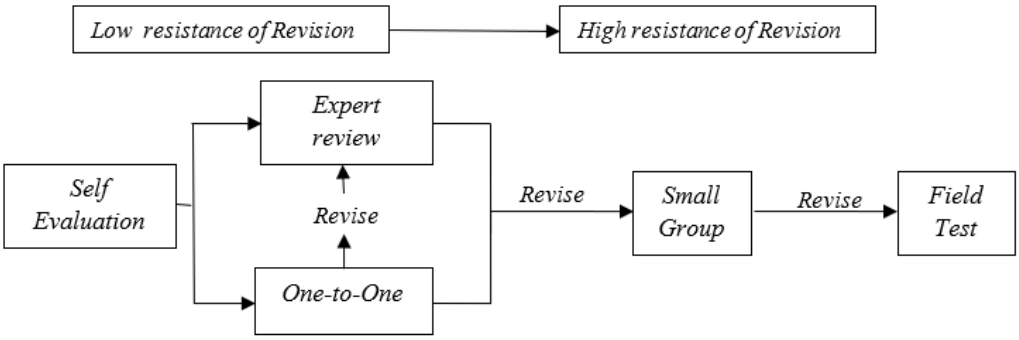

Figure 1. Design of formative assessment (Tessmer, 1993, Zulkardi, 2006)

The criteria of Succes of this research, we got mathematical modeling task using parking fee contexts for Mathematical Learning that was valid for Indonesian vocational high school students. The validity was produced from the experts review of Realistics Mathematics Education Expert, or mathematical modeling expert or mathematics education expert and solution and comment of the student on one-to-one by interview.

The research subject were 2 students SMK Negeri 1 Sungai Menang, Ogan Komering Ilir, South Sumatera, Indonesia. The collected data were analyzed by implementing descriptive analysis method: (1) walk through, walk through by sheet analysis based on the comments of validation of expert to produce valid mathematical modeling tasks; (2) interview and student solution, the analyze the results of one-to-one.

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RESULTS AND DISCUSSION

This study conducted analyzing, design and evaluation. In evaluation, researcher only conducted self-evaluation, expert review and one-to-one.

1. Analyzing Stage

This research begins by analyzing the curriculum, students, real world problems, students' vocational needs. In this stage, researcher conducted analyzing curriculum (basic competence), real world-problem that contain rich mathematically, student and teacher need, and mathematical modeling tasks characteristics.

2. Design Stage

The researcher then observed the real world problem that contains mathematics that can be used for modeling learning in SMK. Then the researcher determined or designed the problem of parking costs in four shopping centers in the city of Palembang. Because of this context, there are issues that need to be explained to the public related to transparency in determining parking fees. Thus, the researchers designed mathematical modeling tasks using parking fee according to the characteristics of Riyanto's research results (2020). The problem of modeling with the context of parking costs is given in Figure 2 below.

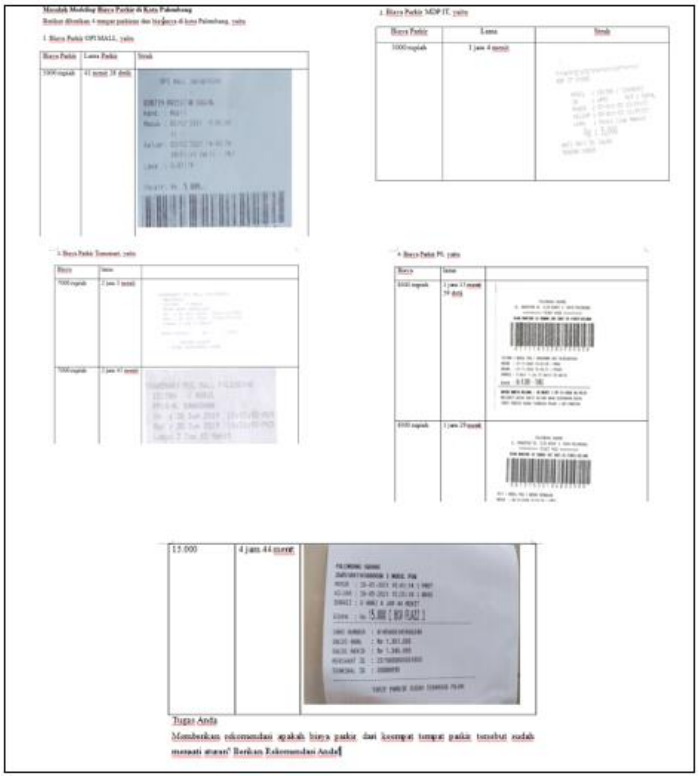

Figure 2. Mathematical Modeling Tasks Using parking Fee in the analysis and design phase

Based on the researcher's analysis, the problem of mathematical modeling in the context of parking costs is in accordance with the characteristics of the mathematical modeling problem of Riyanto's research (2020). This mathematical modeling problem is also compatible with PMRI (Pendidikan Matematika Realistik Indonesia) theory. Activities related to PMRI support stakeholders such as teachers, prospective teacher students, students, teacher educators, researchers, and book writers in reforming mathematics education in Indonesia, so that PMRI is an innovation in sustainable mathematics education (Zulkardi, et al., 2019). This show that this study is to implement innovation in mathematics. PMRI is not much different from learning mathematical modeling (Zulkardi, 2017). Furthermore, Riyanto (2020) that the characteristic of learning mathematical modeling is using a real world context. But, Zukardi (2013) conclude that context can lead to a joyful and meaningful mathematics learning of concepts. So, this research use parking fee context to make learning mathematics joyful and meaningful. Fauziah, et al (2020) state that pedagogical changes in mathematics education reform include the ability of teachers to create a problem-oriented classroom culture and engage students in interactive learning as well as designing learning activities that can encourage the rediscovery of mathematics. Thus, this study supports the results of previous studies.

Zulkardi & Kohar (2018) revealed from the results of their research that the designers of PISA-like tasks which have the potential as a source of learning to improve students' mathematical literacy found several challenges, especially those related to problem profiling and designing tasks/problem that have original or authentic characteristics. This indicate that this research is crucial to conduct.

3. Evaluation Stage

This study conducted only self-evaluation, experts review, and one-to-one. After conducting the analysis and design, the researcher conducted a formative assessment to test the validity of mathematical modeling. The first, researcher conducted self-evaluation the mathematical modeling using parking fee that had designed. In this phase, researcher used Riyanto's (2020) mathematical modeling charateristics. Based on self-evaluation, this mathematical modeling tasks using parking fee was suitable to Riyanto's (2020). Then, researcher conducted expert review. There are two expert reviews, namely the researcher himself (Dr. Bambang Riyanto, M.Pd). Where the topic of his dissertation is Learning Mathematical Modeling. The other one is Dr. Riyan Hidayat, S.Pd., M.Ed.. The topic of his dissertation is also learning mathematical modeling. Riyan said that this Modeling problem is already good, however, it is best to ask questions that follow the modeling steps, like

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making assumptions and so on. Figure 3 show the Riyan's comments. So, in this phase, researchers make revisions based on expert's comment.

Figure 3. Expert's Comment on Experts Review

The researcher revised the modeling tasks on the Student Worksheets by adding questions to the modeling process (scaffolding) according to expert suggestions. Figure 4 shows the results of adding questions to the Student Worksheet.

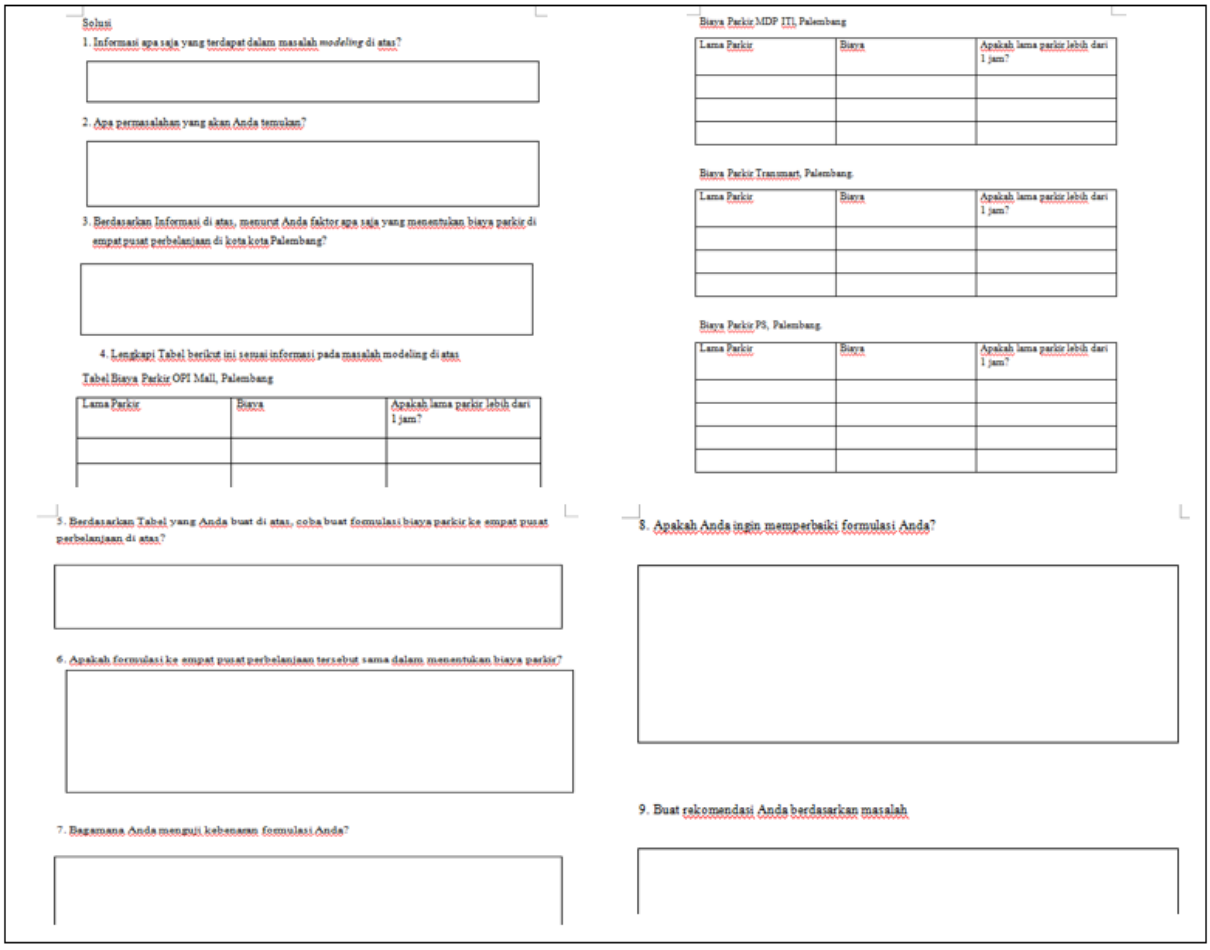

Figure 4. Revision Modeling Tasks on Expert Review

Next, the researcher did a one-to-one test to test the validity of this modeling task. There are two student of Grade XII TKJ and XII AK and teacher of mathematics Edwin Sajili, S.Pd. which the researcher asked to give mathematical modeling tasks to his students of SMKN 1 Sungai Menang as subject research, namely Mahesa and Inka Desi. The solution of the student incated by figure 5. Mahesa only can sunderstand modeling problems, could not make assumptions, could not work mathematically, and have not been able to validate modeling results. But Inka Desi, surprisingly could determine the problem in modeling problems, can determine important variables, can draw conclusions but informally, but could not make assumptions and could not make mathematical models and could not validate them. Inka Desi could solve the problem of parking fees informally, ie not following the modeling process. It instantly divides parking costs by time in minutes, then concludes and recommends without validating mathematically and in the real world. This shows that modeling learning is new for SMKN 1 Sungai Menang because the student could not make assumption in the mathematical modeling process and not following the steps of the mathematical modeling process. This indicate that learning mathematical modeling at SMKN 1 Sungai Menang has the potential to be further developed. Because students already have informal math skills. This is also supported by the research results of Riyanto, et al. (2017) that students could not make assumptions in modeling process which works to simplify the problem because modeling tasks is new for the student in Indonesian. This shows that mathematical modeling is very important to be introduced in schools in Indonesia in accordance with the government program on minimum competency assessment.

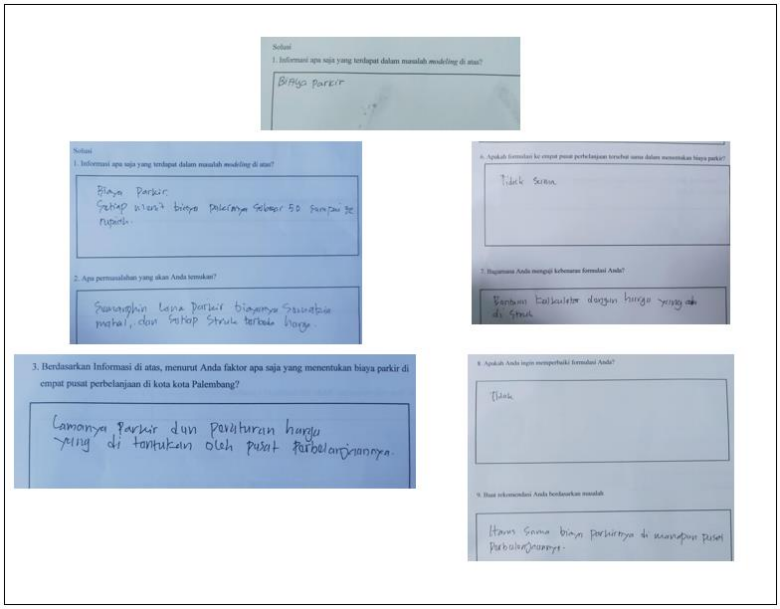

Figure 5. Student's Solution on one-to-one phase.

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Based on students comment, students, i.e. Inka Desi, said that this modeling tasks is a bit difficult. Inka Desi said that I never found this problem. Also, Mahesa said that I have never had a problem like this. Also, Mahesa did not understand the term factors. So, researcher revise the term factors into determinants. These factors are variables that determine the price of parking fees. Figure 6 show student comment in one-to-one phase. This shows that students are not familiar with the modeling process. Edwin's student said that this modeling problem was difficult, did not understand and was confused. This show that SMKN 1 Sungai Menang students have never encountered mathematical modeling problems. This research is very compatible with the research results of Riyanto, et al. (2018, 2019) who reported that students could not make assumptions and could not validate the results of mathematical modeling. This indicates that it is very crucial for teachers, researchers, government to implement learning mathematical modeling to improve students' capabilities in mathematical modeling. This also shows that learning mathematical modeling is promising at SMKN 1 Sungai Menang in particular and schools in Indonesia in general. Also, it is crucial for teachers to carry out real-world-based learning. Research shows the need for teachers to innovate to continue to look for other real problem contexts in the real world, especially the context in the vocational world for the implementation of mathematical modeling learning in SMK, so that it is interesting for students and students are motivated to learn mathematics. This is expected to improve the quality of learning in SMK, especially mathematics and other subjects in general. Zulkardi (2013) argues that it is not an easy working to find a good and relevant context for all mathematical concepts. This research is as a solution for this working.

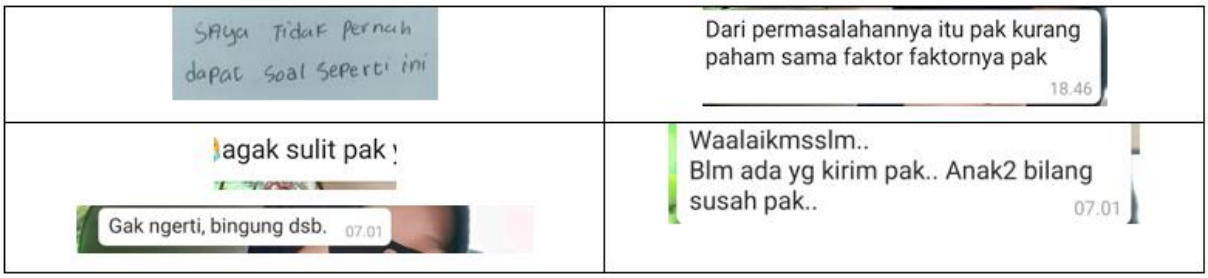

Figure 6. Student's comment on one-to-one phase.

Based on the research results of Riyanto, et al. (2019) that students can create mathematical models in their own way and students are interested in learning mathematics by modeling tasks. This indicates that there is progress in students' mathematical modeling capabilities by learning mathematical modeling. But, this research support the results of previous research, such as the results of research Riyanto, et al (2017, 2018) which indicated that students can make understanding of the

problem in modeling but still have difficulty in making assumptions. So, in this study, students are given guiding questions related to the modeling process or other terms scaffolding or solution plans. Thus, further research should be considered to provide scaffolding in modeling learning. This is caused by modeling is still relatively new for students in Indonesia (Riyanto, et al., 2017, 2018). The same results was reported research in elementary school teacher candidates by Fauziah (2020) that prospective elementary school teacher students are not familiar with PMRI (Indonesian Realistic Education) learning. Where PMRI Learning is the same as Modeling Learning (Zulkardi, 2017). Therefore, modeling learning in Indonesia is very problematic to implement

CONCLUSIONS AND SUGGESTIONS

Based on the results of research and discussion, it is concluded that there are students who have high mathematical literacy skills equivalent to level 5. It is called the ability to develop and work with models in complex situations, identify the problems, and establish the assumptions. In the process, students selecting, comparing, and evaluating appropriately the problem solving strategies relating to complex problems that relate to the model. Working strategically is seen with broad thinking and reasoning processes, and it is precise in connecting symbol representations, formal characteristics and knowledge related to the situations. Even, students are able to reflect their works as well as formulate and communicate interpretations followed by the reasons.

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