Mathematical Modelling Based Learning Design on Relation and Function for Junior High School Students

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Mathematical Modelling Based Learning Design on Relation and Function for Junior High School Students

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ABSTRACT

This research is a design research type of validation studies, which aims to produce a learning trajectory of relation and function material in the form of 4 activities of student worksheets (LKPD). The research subjects were 32 students of Junior High School 19 Palembang class VIII 9, where the focus of the study was two high-ability students, two medium-ability students, and two low-ability students. The subjects were selected based on the students' academic abilities and the recommendations of the teachers in mathematics. We carried the research out in three stages, namely: (1) the preliminary or preparation stage, which includes literature study and data collection; (2) experiments which are the stages of implementing the results of the learning trajectory or hypnotical learning trajectory (HLT); (3) retrospective analysis, which is the stage of analysing the learning outcome data on the previously made learning trajectory. The research was conducted online with a pre-scheduled, scheduled, and post-scheduled learning system. Pre-scheduled and post-scheduled learning uses google classroom and WhatsApp groups, while scheduled using the zoom application. The research data was collected via google classroom and analysed qualitatively. The results showed that the learning trajectory can improve the understanding and ability of students of Junior High School 19 Palembang class VIII 9 in solving problems of relation and function material.

Keywords: *Design research, Validation studies, Learning trajectories, Relations and functions.*

1. INTRODUCTION

Literacy is the main focus of implementing learning today. Literacy skills are also one of the 21st century's ability points beyond other abilities [1]. Especially in mathematics, students with literacy skills can solve problems by recognizing, understanding, and being able to interpret them before carrying out the final solution process. With mathematical literacy, we can help an individual in understanding the role and usefulness of mathematics in actual life and when to use mathematical matters to solve various existing problems [2]. Mathematical literacy also can help an individual in making various kinds of right decisions as a society that builds, cares, and thinks [3, 4].

In the world of education, literacy skills become the basic foundation needed by students, from elementary school to the tertiary level [5]. Literacy itself contains students' mind-sets formed by going through the process by process. The process begins with what students have experienced first, what students will learn, and what kind of learning implementation students will get when the process takes place [6].

Several things are directly related to literacy skills including mathematical proficiency, proficiency in the implementation process, and skills in thinking about future mathematical goals [7]. According to the survey results, it shows that almost 80% of Indonesian students 'literacy skills are below the basic level 2, this is evidenced by several contests, competitions, and assessments conducted to see students' mathematical literacy abilities [8]. Mathematics learning that is carried out should be given in the form of various contextual problems [9]. Because of this, it requires a variety of questions based on the development of the 2013 curriculum that is suitable for learning in Indonesia with mathematical modelling problems [10]. In other words, educators are required to fulfil the competence of educators by being able to design various kinds of questions using contexts that are close to the real-life of these students [11-12].

Contextual problems in the form of modelling are used by various educators around the world [13]. Modelling can solve problems in responding to the challenges of today's needs in solving various current problems that exist in the real world mathematically and have the same goal in every country so they can compete in increasing competence in the field of education itself [14-15].

By improving the learning patterns that are usually carried out in Indonesia, namely learning only limited to existing reading materials and assignments only in the form of questions with conventional methods, it is transformed into a lesson that was designed before [16]. Educators should provide contextual problems with current problems so that students can improve their ability to solve problems in line with the increasing creativity of students in thinking and innovatively [17]. Learning that is carried out can help students carry out the stages of problem-solving until it ends up being a solution including modelling problems into mathematical form [18].

To support this learning implementation, a learning path that contains activities, objectives, and alleged thoughts of students is needed. With a learning trajectory, a teacher can develop learning and analyse the learning process more deeply [19-20]. From the various descriptions above, the researcher chooses relations and functions as learning materials that will be tested in the form of mathematical modelling. This is because it closely relates the material relations and functions to problems that exist in actual life, where students can find problems that are contextual and can apply the ability to solve problems [21-22].

Not only that, there are still many students who do not understand the concept of relations and functions, even confused in understanding each step and procedure and its relationship because of the limited learning media available in the schools [23-24]. The purpose of this research is to produce a learning trajectory that can help students understand the material relations and functions by using a mathematical modelling approach in grade VIII junior high school students.

2. METHOD

2.1 Research Design

This research is validation studies type design research. The research design contains a learning trajectory comprising three related components, namely determining the direction of learning to be carried out or known as learning objectives, implementing ongoing learning process, and student conjectures regarding contextual learning activities implementation [25].

The research carried out comprised three stages, namely: (1) the preliminary or preparation stage, (2) the experiment comprising the pilot experiment and teaching experiment stages, (3) retrospective analysis [26][27].

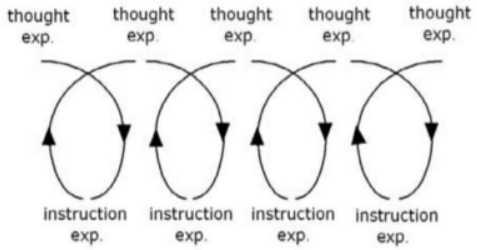

Figure 1 A cumulative cyclic process in design research [26].

In analysing the designs that have been made, it needs several actions in assessing the suitability limits of several assumptions and making improvements based on certain aspects contained by the cyclic process of thought experiments and experimental instructions [28][29].

2.2. Procedure of Design Research

The first stage carried out is preliminary, where at this stage the researcher carries out the initial process by reviewing various kinds of literature related to existing mathematical modeling-based learning designs that have been previously researched.

The second stage carried out by the researcher was the experiment, which at this stage consisted of several stages, namely the pilot experiment stage and the teaching experiment stage. At the pilot experiment stage, a pilot experiment is carried out to review the design made in the form of HLT or learning trajectory whether it is in accordance with the initial abilities of the students to be tested. As for the general description of HLT as the following table.

Table 1. Overview of the HLT for learning on relation and function

Activity	Main Goals	Description of Activity	Conjectures of Students' Thinking
Flash drive and Price	a. Students can define relations appropriately b. Students can find examples of relationships in everyday life appropriately	a. The teacher provides LKPD Activity 1 through Google Classroom to students b. Students are asked to solve problems individually within the given deadline c. The teacher directs students to be able to state a relationship and mention examples in daily life problems	a. Some students write down the problem information b. Some students stated that the name of the flash drive was the set of A and the price of the flash drive was the set of B c. Some students draw a Cartesian diagram based on the problems given d. Some students provide flash drive solutions that will be purchased with their arguments e. Some students can mention examples of relationships around them
Flash drive and Warranty	a. Students can show a relation with an arrow diagram and a set of consecutive pairs correctly b. Students can define a function appropriately	a. The teacher provides LKPD Activity 2 through Google Classroom to students b. Students are asked to solve problems individually within the given deadline c. The teacher directs students to be able to state relationships using arrow diagrams and a set of consecutive pairs and states the problem is a function with the right reasons	a. Some students write down the problem information b. Some students state the problem in the form of an arrow diagram and a set of consecutive pairs c. Some students provide flash drive solutions that will be purchased with their arguments d. Some students state that the problem given as a function with the right reasons
Flash drive Storage	a. Students can explain relationships and functions appropriately b. Students can distinguish between functions and	a. The teacher provides LKPD Activity 3 through Google Classroom to students b. Students are asked to	a. Some students write down the problem information b. Some students provide solutions to the film to

	non-functions precisely	solve problems individually within the given deadline c. The teacher directs students to be able to know the characteristics of the function and states that the function is a relationship, otherwise the relationship is not necessarily a function through problems	be downloaded with their arguments c. Some students state the problem in the form of an arrow diagram d. Some students solve problem-related to flash drive storage space e. Some students may statement the problem as functions and not functions with good reason
Flash drive Specification	a. Students can solve contextual problems related to relationships and functions appropriately	a. The teacher provides LKPD Activity 4 through Google Classroom to students b. Students are asked to solve problems individually within the given deadline c. The teacher encourages students to be able to solve contextual the problem related to relationships and functions	a. Some students write down the problem information given b. Some students share their arguments regarding a superior flash drive c. Some students state the formula for the function of the problems d. Some students solve problems related to the length of time and test the speed of reading and writing data on a flash drive e. Some students can give examples of relation and functions around them and conclude problems

Next is the teaching experiment stage, where in this stage the researcher carries out the learning trajectory or HLT that has been made and is directly tested on students in the form of problems related to relationships and functions four times online with several activities in it.

The last stage is retrospective analysis, the researcher compares the learning trajectory made before being tested directly with the results of data analysis after the research is carried out.

The subjects of this study were 32 students of Junior High School 19 Palembang grade VIII 9. we conducted the research online by carrying out several stages that included activities to support the learning of these relations and functions. In this study, the focus of the study was six students with high, medium, and low

abilities. Learning activities that contain LKPD each activity was done individually by students, so it allows and makes it easier for researchers to analyze the data obtained, especially on online learning.

3. RESULT AND DISCUSSION

The research was carried out online through the zoom application by producing a learning path related to relationship material and modelling-based functions using a flash drive context. This research was attended by grade VIII 9 students of Junior High School 19 Palembang and was accompanied by a mathematics teacher who was one of the research observers. It was the researcher who became the model teacher in carrying out four learning activities during four meetings in one month, which became the stage of the teaching experiment.

In implementing the teaching experiment process, the LKPD design use 4 activities of relation and function material based on the learning trajectory that has been made the problems given are based on mathematical modeling.

3.1. Activity 1

Inactivity 1 students carry out online learning using the zoom application for 40 minutes, which has previously been notified on the WhatsApp group regarding links and learning schedules. Three days before implementing the model teacher had asked students to learn reading books about the initial material of the relationship, asked students to record what information they got and asked students to write questions if anyone did not understand the reading material provided.

At the time of the learning process, the model teacher started learning by doing an orientation by saying the opening greetings followed by praying together, then the teacher made an apperception by asking the previous chapter material, namely the coordinate system.

Figure 2 Relation learning videos.

After watching the video lesson about relationships, the model teacher opened a discussion session with the students first and asked the students to present what they got from the reading material and the video that was given.

Rio and Andi were walking around an electronic shopping center in Palembang City. They both want to buy a 16 Gb flash disk as a place to store data so they don't lose, here is the brand data and the price of each flash they find:

No	Name of Flash drive	Price
1	Sandisk	Rp 42.500,00
2	Toshiba	Rp 23.000,00
3	Lexar	Rp 41.000,00
4	Kingstone	Rp 35.000,00
5	Vgen Astro	Rp 39.500,00

Rio and Andi are confused about which flash drive with which capacity the same but at different prices. Rio and Andi hoped that they would not be wrong to choose a flash and the selected one really according to the price offered.

Questions

1. Write down what information you know about the problem above State the name of the flash as set A and the price of the flash as set B !
2. Draw a Cartesian diagram of the relationship between set A and set B!
3. Which flash drive should Rio and Andi buy? Give the reason!
4. Is the relationship between sets A and B above included as a relation? Give it the reason!
5. Give examples of relationships that are around you!

Figure 3 LKPD activities 1.

3.1.1. LKPD 1 Flash drive Context and The Price

LKPD activity one with flash drive context and the price is given by the model teacher to students in pdf form in Google Classroom with a limited deadline. The following are the results of students' answers regarding the problem.

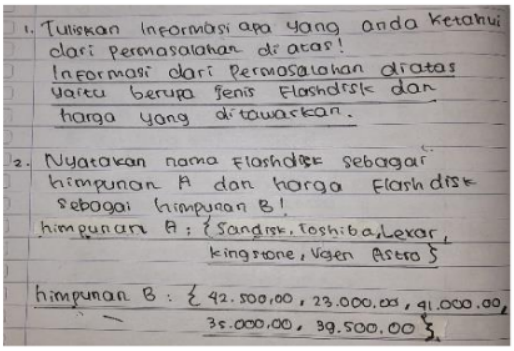

Figure 4 Completion of activities 1 no 1 and 2.

Based on the picture above, students can understand the problems given in the form of a flash drive and the price that Rio and Andi will buy, or this process is called an understanding task. In the next question, it is seen again that there is a process of students being able to search for problem data given or this process is called searching mathematics by being able to make a

collection of contextual problems, either set A as the name of the flash drive or set B as the price of the flash drive to be purchased.

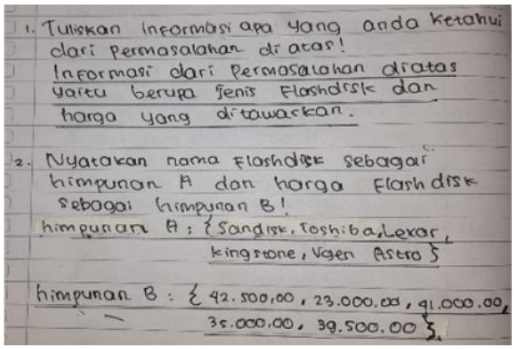

Figure 5 Completion of activities 1 no 3, 4 and 5.

Furthermore, it is also seen that students solve the problem, namely drawing a Cartesian diagram which at first is only a contextual problem regarding the flash drive and its price, that's when students have entered a process known as using mathematics by using their initial understanding and abilities regarding relations after carrying out scheduled learning. For the next question, students are asked to be able to choose which flash drive to buy, the solutions offered by students vary such as affordable prices, widely known products, and so on.

As for the next question, students can state the problem given whether it is a relationship, this is where students enter the explaining result process by using their understanding after learning together with the relations material independently through reading material or when learning online together using zoom.

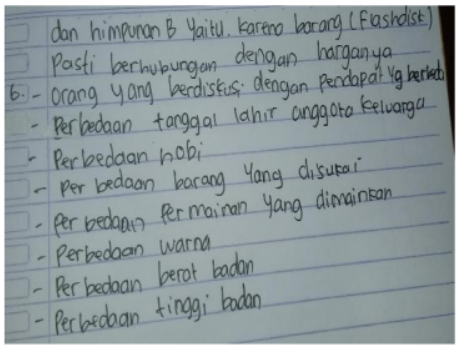

Figure 6 Completion of activity 1 no 6.

The final problem given to students is being able to find various kinds of relationships around them with the intention that students can understand what the real relationship is, not only in the example in question. This process can also be referred to as a stage in reviewing the initial problems given on the LKPD activity one sheet regarding the flash drive and its price.

3.2. Activity 2

Activity 2 is carried out after one week after the end of the previous activity, with the same process and stages. Starting with pre-scheduled learning, which is three days before carrying out scheduled learning, students are asked to read the reading material again about the initial material of the function, ask students to record what information they get, and ask students to write questions if anyone does not understand the reading material provided.

Rio and Andi asked an employee at an electronics shopping center. This is about the warranty of each flash drive they have previously seen, with data as follows:

No	Name of Flash drive	Product Warranty
1	Sandisk	5 years
2	Toshiba	-
3	Lexar	5 years
4	Kingstone	2 weeks
5	Vgen Astro	Life time

Rio and Andi, who initially got their choice back confusion when knowing the product warranty provided varies each the flash drive.

Questions

1. Write down the information you know about the problem above!
2. Make an arrow diagram from the flash drive name table and the warranty it gets from the problem above!
3. State the set of consecutive pairs based on the previous problem!
4. If it's still at the same price, which flashes drive should Rio and Andi buy? Give the reason!
5. Are the above problems a function? If so, why? If not, please the reason!

Figure 7 LKPD activity 2.

Students were asked to prepare stationery to record important information from the learning video.

Figure 8 Function learning videos.

Furthermore, entering the question and answer session, no student wanted to ask questions so that the model teacher tested the students' understanding in participating in learning activities 2. Given a diagram of arrows connecting members of set A, namely the names of people, and set B, namely the fruit that was liked. Students are very enthusiastic in answering these activities by mentioning the domain, domain and range

then they can state that the activity is a function by giving the right reasons. it shows they understand.

3.2.1. LKPD 2 Flash drive Context and Warranty

LKPD activity two is in the form of problems regarding relations and functions in the context of Rio and Andi's problems regarding the flash drive guarantee they will buy. LKPD uploaded to Google Classroom with a limited processing deadline. The following is solving student problems related to LKPD 2.

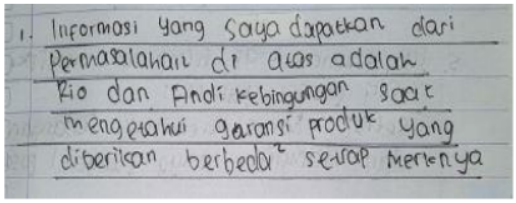

Figure 9 Completion of activity 2 no 1.

The answer to activity 2 shows, students can understand the problems given in the form of a flash drive and the warranty offered, where the flash drive will be purchased by Rio and Andi. By understanding the problems given states that students have entered the process of mathematical modeling, namely understanding task.

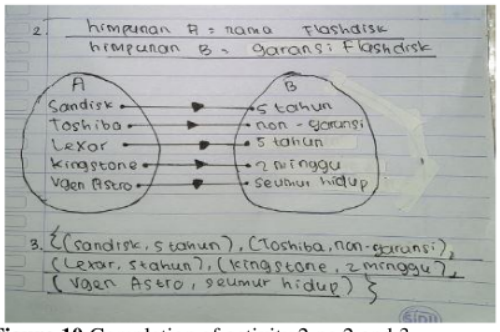

Figure 10 Completion of activity 2 no 2 and 3.

Students can state the problem into a diagram that comprises a set A as the name of the flash drive and set B is the guarantee provided from the flash drive. However, it appears that students write down the same members of set B twice, namely a five-years warranty. This will be corrected to be more precise if only one member of the association is the same and will be discussed a little at the next meeting. In the next question, the students have understood how to state the set of consecutive pairs, this shows that the students have entered the searching mathematics process by looking for the data on the problems given. Not only that, students have been able to provide solutions for for the data on the problems given. Not only that, students have been able to provide solutions for which flash drive that Rio and Andi will buy with various arguments for each student.

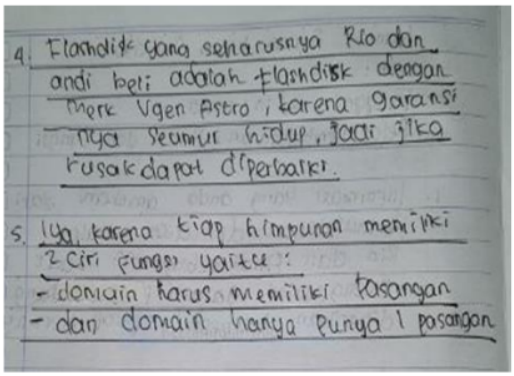

Figure 11 Completion of activity 2 no 4 and 5.

Based on the results of students' answers to the last problem, students can state that the problem given is a function by two functional characteristics, namely each domain must have a partner and the domain only has one pair. When starting the problem as a function, students have entered the process of explaining the results by understanding the definition and characteristics of the functions itself so they can provide the right reason.

3.3. Retrospective Analysis

After carrying out learning activities both pre-scheduled, scheduled, and post-scheduled, some data were obtained such as the results of each activity's LKPD, test results in the form of pre-test and post-test, as well as student interviews regarding the learning they took based on the learning trajectory that the researchers previously made.

Researchers analyzed data on learning outcomes that had been carried out with a learning trajectory in the form of HLT containing conjectures and assumptions while students towards the design of student worksheet activity one to activity four were ultimately under the expectations of the researcher. The formulation of the problem that the researcher made previously was finally answered, where the learning trajectory of the relations materi and the functions that the researcher made could help students understand the material relations and functions by using the mathematical modeling approach in grade VIII junior high school students[30].

This is in line with the results of the pre-test that was tried out before the study with an average score not far from the completeness of the minimum criteria or KKM, which is seventy-five, even some students get a score below it. It is inversely proportional when the post-test results are obtained which are tried out on students after learning using the LKPD design as many as four activities.

4. CONCLUSION

Based on the description of the previous finding and interpretation, it can be concluded that the learning trajectory produced in research related to relation and function material using a mathematical modelling approach can help students understand more easily the material relations and functions compared to conventional learning as usual. Where students carry out the stages from problem recognition to get the final solution to the problem and can provide various kinds of innovative creative solutions, and can explain arguments appropriately. The following are the stages of student understanding of contextual problems given regarding the material relations and functions.

Students can understand the relationship of contextual problems regarding the flash drive and the price that rio and andi will buy, with several problems such as being asked to state in the form of sets a and b, making a cartesian diagram of the problem, being able to state the problem as a relation with the right reasons, and students can provide various examples of the relationships that exist around them. This can ensure that students understand the material relations which is one of the objectives of the research.

Students can understand the function of rio and andi's contextual problems regarding flash drive and the warranty provided, with several problems such as making arrow diagrams, stating problems into consecutive set pairs, providing solutions for various flash drive which rio and andi will buy, and students are able states the problem is a function or not with the right reasons. It can also ensure that students properly understand the material functions that are the purpose of the study.

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