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Are students more interested in solving mathematics problems related to reality?

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Abstract

Eleven lower-achieving girl students (13/14 years old) were asked about their task-specific interest in solving mathematics problems that either related or did not relate to reality, both before and after solving problems. Six of the eleven students were interviewed about the reasons behind their interest in particular problems. Furthermore, an interview was also carried out with a mathematics teacher, to know the types of problems that students usually worked on and students' interest in those problems from a teacher's point of view. The analysis revealed that students possessed different interests concerning problems, which either related or not with reality. However, generally, they preferred to solve problems that had no connection to reality, because they were easily able to work on such problems without much confusion.

Keywords: Students' interest, modelling problems, dressed-up word problems, intra-mathematical problem.

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1. Introduction

I am always interested in giving my students problems that have connections to reality, in order to make them realise that mathematics exists in their lives and is embedded in their daily activities. By solving these problems, I believe that students could develop their critical thinking ability in synchronising real-life situations with the mathematical concepts that they learn. De Lange (1996 as cited in Gainsburg, 2008) shares a similar positive notion about real-world problems that allow the student to get a depth of understanding of mathematical concepts. This argument is reasonable because by applying the concepts to solve real-world problems, these concepts become more visible for the students. However, a recent study by Schukajlow et al. (2012) suggested that students were not always interested to solve real-world problems. This finding makes me realise that I am rarely concerned about students' perspectives relating to problems that are most interesting for them. In order to seek students' point of view about problems they enjoy to work on the most and to find out more evidence to justify the result of the study by Schukajlow et al. (2012), this study aims to answer the question, 'Which kind of problems do students enjoy to solve the most and what are the reasons behind their preferences?'

2. Theoretical background

2.1. Interest

Interest is a trigger for doing activities such as learning. According to Krapp (2000), '(a)n interest represents or describes a specific relationship between a person and object in his or her 'life-space' (p.111). One example of what is meant by Krapp is the relationship between a learner and a mathematical task. Since a mathematical task serves as one of the assessments to check students' understanding of mathematical concepts, I believe that more effort would be given by an interested learner in problem-solving compared to an uninterested one. This is supported by Pintrich (1999) that the students would engage more repeatedly in the self-regulation of their learning process when they look at their task as interesting and meaningful. Furthermore, both Hidi and Baird (1988) and Krapp (1989) (as cited in Mitchel, 1993) differentiated interest into two categories: personal interest and situational interest. While personal interest was already possessed by a person before entering a particular environment and context, situational interest was gained by participating in such an environment or context (Mitchel, 1993). This paper will focus on situational interest, because it is changeable and a teacher is able to control it (Schraw et al., 2001). Additionally, Schraw, Flowerday & Lehman (2011) also state that situational interest could be increased by giving the students a task that is novel, challenging, concrete and relevant to the learning goal. Thus, engaging students with different types of mathematical tasks would influence their situational interest.

2.2. Mathematical problem

Niss, Blum and Galbraith (2007) divided mathematical problems into three types: modelling problems (MP), dressed-up word problems (DP) and intra-mathematical problems (IP) (as cited in Krug & Schukajlow, 2013). The differences between these problems lie in their connection to reality. MP are defined as problems that require a translation process from the real-world situation to the mathematics (Blum & Ferri, 2009). One of the modelling cycles to solve these problems was proposed by Blum and Leib (2006), as follows: 1) understanding the problem by constructing the situation model of the problem; 2) simplifying and structuring the situation model in order to create a real model; 3) mathematising or transforming the real model into a mathematical model; 4) finding the mathematical results by doing calculation or mathematical procedures; 5) translating these mathematical results into real-world situations in order to get the real result; and 6) validating this

result in order to check any errors throughout the process (repeating the process from the second step is necessary, if the result is inadequate).

DP also relate to reality but the mental activity to find the solution to these problems is more simplified compared to MP (Schukajlow et al., 2012). In other words, these problems could be identified by three characteristics, as follows: '(1) .the real model is already given in the task; (2) the data for finding the solution are already given in the text and no other data are needed for development of solution; and (3) 'modelling loops' for validation the real result is unnecessary' (Krug & Schukajlow, 2013, p. 3).

IP are problems that have no connection to reality (Schukajlow et al., 2012). These problems can be executed using appropriate mathematical concepts and procedures and there is a limited validation in checking the mathematical activity of the problem (Krug & Schukajlow, 2013).

3. Methods

3.1. Design and sample

Eleven British lower-achieving girl students from one class of eighth grade, about 13–14 years old, were asked about their interest regarding three types of mathematical problems. Their interest was noted both before and after solving the three problems by filling in a questionnaire about their task-specific interest following each problem. Additional interviews were carried out with six students and a mathematics teacher. The students were interviewed to seek information about the rationale behind their interest. The interview with the teacher aimed to check what kind of problems the students usually worked on in the classroom and students' interest in those problems based on the teacher's perspective. Furthermore, an investigation was also held concerning students' exercise books and the textbook used by the teacher.

3.2. Three mathematical problems

Three problems were provided related to the area of circles, which consisted of one MP, one dressed-up word problem and one intra-mathematical problem. Each problem is presented below.

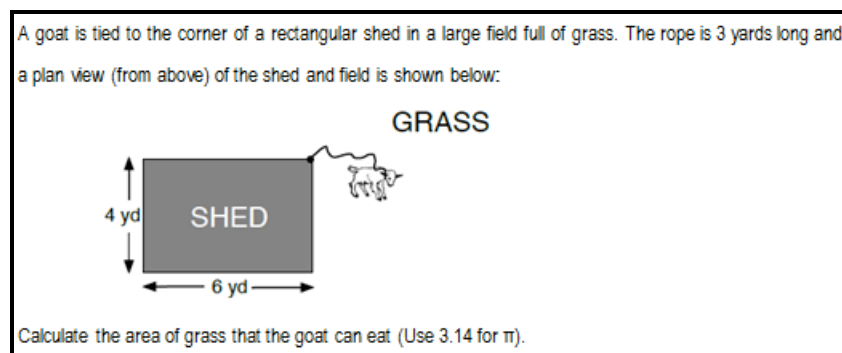


Figure 1. Modelling problem

The 'goat and grass' problem could be classified as a MP because it requires modelling steps to solve it: 'An individual model of solution has to be constructed when the problem is read and the picture is viewed' (Krug & Schukajlow, 2013, p. 3). This model includes the geographical location of the shed and the field, which is full of grass. The problem solvers need to imagine when the goat pulls the rope until it is tightly stretched and which sides of the shed the goat could reach. The goat would be able to reach half of the length of shed on the left side and three-quarters of the width on the right side. This image depicts the real model of accessible field for the goat that should be mathematised at

the next step. The parts of the field that can be accessed by the goat are seen mathematically as a circle, which has a quarter cut out by the shed. Then the formula of area of circle could be used to find the answer. Finally, the result of the calculation can be validated by checking back to the information from the text and picture.

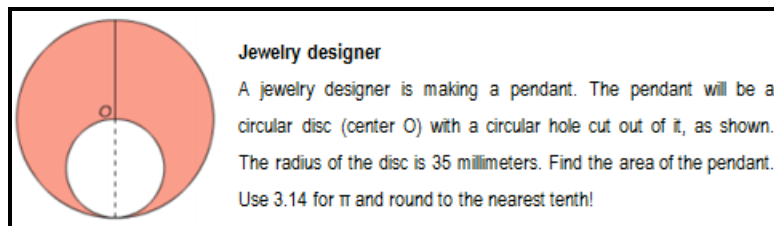


Figure 2. Dressed-up word problem

The 'jewellery designer' problem can be categorised as a dressed-up word problem because the situation in the problem has been simplified and presented precisely by the given picture. In other words, the modelling process is almost unnecessary. By recognising two circles as parts of the pendant, the mathematical model of the problem is directly visible. The area of the pendant can be calculated by taking away the area of the small circle (hole of pendant) from the area of the circle-shaped pendant (big circle).

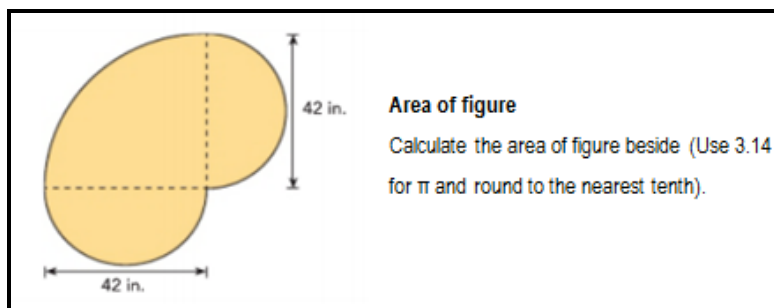


Figure 3. Intra-mathematical problem

The intra-mathematical problem, 'area of figure', can be solved by the same mathematical procedures as the 'jewellery designer' problem using the formula of area of circle.

3.3. Interest scale

The three problems were given to the students in a worksheet, where each problem was followed by the questionnaire about students' interest. The questionnaire was adopted from the one created by Krug and Schukajlow (2013), which has high reliability. The worksheet consists of two parts. The instruction for the first part was, 'You do not need to solve the problems. Just read the problems carefully and answer the question about to what extent do you agree with the statement (It would be interesting to work on this problem)'. The instruction for the second part was, 'Solve each problem and then answer the question about to what extent do you agree with the statement (It was interesting to work on this problem)'. The answer grid for the questionnaire was made using a 4-point Likert scale (1 being completely disagree and 4 being completely agree).

4. Results and discussion

4.1. Result

The results of the students' questionnaires are shown in Table 1.

Table 1. Questionnaire results of students' interest

Students' code	Before solving problems			After solving problems		
	MP	DP	IP	MP	DP	IP
1	Agree	Agree	Agree	Agree	Agree	Agree
2	Agree	Agree	Disagree	Disagree	Disagree	Disagree
3	Completely disagree	Agree	Agree	No response	No response	No response
4	Agree	Disagree	Disagree	Completely disagree	Completely disagree	Agree
5	Disagree	Disagree	Agree	Agree	Agree	Completely agree
6	Agree	Completely agree	Completely agree	Agree	Completely agree	Completely agree
7	Agree	Disagree	Agree	Disagree	Agree	Agree
8	Completely agree	Agree	Completely agree	Agree	Agree	Completely agree
9	Completely disagree	Disagree	Completely disagree	Completely disagree	Completely disagree	Completely disagree
10	Agree	Agree	Completely agree	Disagree	Completely agree	Completely agree
11	Disagree	Disagree	Disagree	No response	No response	No response

The interview was done to clarify students' interest related to the three kinds of problems and the reasons why they are interested to solve these problems. Students' responses to the question, which is the most interesting problem for them, are different as follows:

1. I: Among the three problems which one is the most interesting for you and you enjoy working on the most?
2. S1: Probably the third problem (IP) because I got to do it in separate parts which makes it more complex, which makes me have to think harder. I love anything to do with problem solving.
3. S2: I like the first one (MP) the most because I like the story inside the problem. The story is interesting.
4. S3: I like steps and organising. I choose the third problem (IP) the most because it involves circle and circle. Have it and use calculator to solve it.
5. S4: The first problem (MP) is fun because it got like shed and numbers around it. I like the story of the problem. But the third one is okay...I know something about pi and radius.
6. S5: I found the third problem (IP) is easier because it is split up and I know how to work out each different parts and get the full answer.
7. S6: I enjoy to solve the third problem (IP) because it is usual shape.

Similarly, students' responses as to which problem the students do not really enjoy to solve were also various, as follows:

8. I: Among the three problems which one is the most uninteresting or difficult for you and you did not enjoy working on the most?
9. S1: The first one (MP) because it mixes the circle and rectangle. That is why I was quite getting confused.
10. S2: The second problem (DP) makes me confused. I do not understand the circle inside the circle.
11. S3: The first problem (MP) is difficult but after trying to solve it, I could work on it.
12. S4: I do not even try the first problem (MP). Basically I just started and it looks really hard. I just do not look at it properly.
13. S5: I do not like the first problem (MP) because it is confusing me. It is probably more realistic. We have to think about it differently. I found it is harder to visualise it.
14. S6: I enjoy to solve the three problems.

Furthermore, investigation which was carried out regarding students' textbook and exercise book also revealed important information. Generally, the textbook that is used by the teacher consisted of mostly IP with a few word problems. Consequently, students' exercise books also contain mostly intra-mathematical problems

4.2. Discussion

Table 1 tells us that more than 50% of the students agreed that MP were interesting for them after reading. S2 and S4 mention that the story embedded in the MP is interesting and attracts them. However, it seems that they did not enjoy solving the problem, because most of them suggested a disagreement to the statement that, 'it was interesting to work on this problem'. As mentioned by S5, she got confused and it was harder for her to visualise this problem because it was more realistic and she needed to think differently in order to do it. It seems that students' difficulty in visualising the problem was caused by their lack of understanding while reading. I believe that if the students could read the problem properly and have a sense of the problem, they would be able to visualise and solve the problem correctly. An argument from S4 that she did not look at the problem properly because it looked hard justifies students' ambiguity to this problem.

Additionally, there is an intriguing image from Table 1 showing that three of the students showed interest in the MP before and after solving the problem. This could be interpreted that the students liked the problem at the beginning and were able to work on it. This image is impressive because the interview with their mathematics teacher revealed that the students had never worked on MP before. So, it can be assumed that, although the students never engage with the MPs, they do have the capability to engage with it. Perhaps some of them have good visualisation ability, which helps them to be able to simplify and construct the real model of the problem easily.

On the other hand, students also show interest in DP and their interest changes positively after solving the problem. However, from the interview results, it seems that this problem is positioned as their middle category because none of them chose it as the most interesting problem and only once said that it was the most difficult one. For the student who claimed this problem to be the most difficult one, it may be because the problem is not realistic for them, especially the pendant. She may never have seen a pendant necklace before, which is why she just sees the picture of a pendant as a circle inside a circle, which makes her confused. This case may be one limitation of this study in that there is a lack of investigation of whether the problem given is realistic or not for students.

Regarding intra-mathematical problems, the result of the questionnaire shows that this problem is the most preferred one for students. Compared to the other two problems, the proportion of students that labelled this problem as an interesting problem both before and after working on it was bigger. This result is supported by the statements from the interviews. For example, S3 mentioned that she

liked steps and organising and was able to solve this problem by using her calculator. On the other hand, this problem was easy for S5 because it is split up and she knows how to work on it by using the formula of the area of a circle. The image that most of the students seemed to enjoy working on more, i.e., intra-mathematical problems, was justified by their teacher saying that, 'generally the students like to get into the answer quite quickly, so I think they like to do intra-mathematical problems'.

5. Conclusion

The answer to the research questions, 'Which problem is the most interesting for the students?' and, 'Which problem do they most enjoy to work on?' cannot be revealed obviously by the questionnaire. It seems that students have different interests to each problem. As said by their teacher, 'it depends on who they are, some of students like questions with a short answer (IP) but some of them enjoy to work on more challenging problems (DP and MP) because they like spending a longer time on the problem and thinking of it'. However, from the results of the interview, it can be concluded that the intra-mathematical problem was the most enjoyable for students because generally their interest in this problem remains the same during both working on it before and after. For this case, it seems that the reason behind this interest is how able they are do this problem, supported by the fact that they usually work on this problem for their daily mathematical exercises. Therefore, this result is in contrast with the finding of the study by Pekrun et al. (2007) that students enjoy more to work on word problems, rather than pure number problems (intra-mathematical problem). For some reasons, the difference in this finding is plausible. This may be might because of the content of the problems and the types of the student and teaching and learning processes that are experienced by students.

The main limitation of this study is the validity of the questionnaire and the realistic content of the problems. Some students who were interviewed argued that they did not really understand the questions of the questionnaire so that they did not take it seriously while filling it out. This may be the reason why there is no response in the questionnaire. Next, for the dressed-up word problem, the realistic content of the problem needs to be checked again, as some students got confused with the 'pendant'.

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