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Designing Creative Problem-Solving Based Students' Worksheet to Finding Pattern

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33

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ABSTRACT

This study aims to design a creative problem-solving based students' worksheet to help students practice finding patterns. This research is design research. The instruments used in this study consisted of student worksheets, observation and interviews. Data analysis used was a qualitative method. Based on the results of data analysis, the designed student worksheet was generally categorized good both in theory and based on the results of the focus group discussion, although a little revision was still needed before it was tested at the trial stage. From the results of trials and observations, it was concluded that there were students who did not understand the meaning of the questions presented in the student worksheet. The information written by students was irrelevant to the information on the problem and was less relevant to the questions asked. However, after tracing from the interview, it was found that the cause of the unsynchronized question and answer was due to the fact that the language used was not in line with student perceptions and was considered too abstract for some students. From the results of the answers it was also seen that students did not examine implied and expressed information deeply when solving a problem.

Keywords: Designing, Creative Problem-Solving, Worksheet, Finding Pattern.

1. INTRODUCTION

In the context of mathematics education, abstraction is a process of studying abstract things [1], whether ideas, objects or learning concepts in learning mathematics [2]. This is in line with the characteristics of mathematics itself through conditions related to something abstract [3]. Abstraction ability in mathematics is very important for every student to possess [4], since abstraction ability is an ability used to describe mathematical concepts in a mathematical problem [5].

However, there are still many students who find it difficult to think abstractly [6]. This difficulty is in the form of students' inability to represent visual problems into language [7] and unable to interpret mathematical problems presented in the form of mathematical symbols [8], this is due to the lack of student involvement in the formation of abstractions [9], and teachers do not provide opportunities for students to solve problems mathematically [10].

One of the fundamental causes is insensitivity to a pattern that exists in each problem [11], or often known as pattern observation [12]. Pattern observation is a condition in which students realize that there are unique patterns [13] or rules that appear because of the search for the problem-solving strategy they choose [14]. Difficulty in being sensitive to a pattern can be caused due to lack of practice [15], not understanding the meaning of the questions, and students rushing when solving problems [16]. One material that is difficult for students to solve is material about congruence [17]. Students have a lot of difficulty in identifying which shapes will be compared [18], which sides correspond, and which angles correspond to in a complex problem [19].

The teaching materials, worksheets and books that have been available so far are considered inadequate to lead students to solve complex problems [20]. The teaching materials, worksheets, and books available are still general in nature, the majority only present the problem and display the solution [21]. This makes

7

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681

students less sensitive in identifying a uniqueness that characterizes identification to find patterns [22].

As an effort to solve the aforementioned problems, this study aims to design a teaching material in the form of *Creative Problem-Solving* (CPS) based student worksheet. The choice of CPS as a basis for worksheets is due to the difficulty of students in complex problems, besides this CPS requires creativity and is likely to involve many strategies in problem solving [23]. In addition, the stages in CPS have the potential to lead students to identify and find patterns [24].

2. METHOD

2.1 Research Procedure

This research is a part of design research since it aims to design a creative problem-solving based students' worksheet to help practicing pattern discovery. This research consisted of five stages, namely: Preliminary Design, Focus Group Discussion, Trial, Observation-Interview, Retrospective Analysis [25]. The instrument used in this study consisted of students' worksheet, observation sheets, interview sheets.

At the preliminary design stage, it started with a literature study on CPS, the concept of finding patterns and their relationship to the material to be taught, and then put it in the form of student worksheet. At the focus group discussion stage, the researcher and the teacher made predictions of alternative answers to students and look at the weaknesses of the designed worksheet. The next stage was trials, observation, and interviews. This stage aimed to determine whether the designed worksheet can be used by students, as well as to find out the difficulties experienced by students when working on the worksheet. The final stage was retrospective analysis. At this stage all the findings in the study were analyzed and then used to improve student worksheet.

2.2 Subject

The subjects of this study were three Grade IX.b students of SMP Negeri Indralaya. The characteristics of the students in Grade IX.b were categorized as heterogeneous consisting of a mixture of high-ability, medium-ability, and low-ability students. The three subjects also consisted of good, medium and low mathematical abilities. This is meant so that the designed worksheet can be used for all students.

2.3 Instrument

Data collection techniques used were student worksheet, observation, and interviews. The worksheet consisted of three problems that students must solve within 80 minutes. The interview used a semi-structured type, this was meant to make questions can be developed as needed. The interview was used to get clearer information on the students' reasoning in solving mathematical problems. The focus of the interview was on the aspect of recognizing the basic units that produce patterns and making patterns.

2.4 Data Analysis

The data analysis technique was divided into two parts, they were data analysis of worksheets and data analysis of interview results. The data from the worksheets were analyzed qualitatively and grouped into several indicators, they are: (1) recognizing the units that produce patterns and (2) making patterns. In this study, the analysis of interview data began with transcription of conversations between teachers and students. Furthermore, the result of the transcript was reduced and selected whichever information was categorized as important data. The results of this reduction were presented in the form of a description to be juxtaposed with the test result data. The conclusion phase was the process of compiling information obtained from the results of the tests, observations, and interviews and then compared all the data with the theories that form the basis of this study.

3. RESULT AND DISCUSSION

The technique of presenting the results of this research referred to the research procedure which consisted of Preliminary Design, Focus Group Discussion, Trial, Observation and Interview, Retrospective Analysis

3.1 Preliminary Design

At the preliminary design stage, it started with a literature study on CPS, the concept of finding patterns and their relationship to the material to be taught, and then putting it in the form of student worksheet. The results of the CPS theoretical analysis showed that the CPS included: Visioning or Objective-Finding, Fact-Finding, Problem-Finding, Idea-Finding, Solution-Finding, Acceptance-Finding.

The results from the analysis of the pattern discovery concept indicated that each sense can directly observe the pattern. Visual patterns in nature are often chaotic, never really repeat themselves, and often

involve fractals. Natural patterns include spirals, meanders, waves, foams, timings, cracks, and those created by the symmetry of rotation and reflection. Patterns have an underlying mathematical structure; [1] Indeed, mathematics can be seen as a search for regularity, and the output of any function is a mathematical pattern. Likewise, in science, theory explains and predicts order in the world. A pattern is an order in the world, in man-made designs, or in abstract ideas. Thus, the elements of a pattern repeat in a predictable way. A geometric pattern is a kind of pattern that is formed from geometric shapes and is usually repeated.

In mathematics learning, recognizing patterns is defined as the activity of looking for regularities in data to solve problems. Students look for items or numbers that are repeated, or series of events that repeat themselves.

The results of the material analysis showed that congruence material discusses the terms of the congruence of a flat shape, the similarity of two triangles, the terms of the congruence of two triangles, the conditions of a congruence of a flat shape, a congruence of two triangles, and the terms of a congruence of a two triangles.

Based on the above theory, then it was written in the form of a worksheet. In addition to containing identity components such as learning objectives and work instructions, the worksheet also contained a summary of the material containing the basic concepts of congruence, the problems presented were problems that require higher-order thinking and were combined with questions to lead students to find patterns and conform with CPS characteristics. In addition, the worksheet was also equipped with pictures to make it look more attractive.

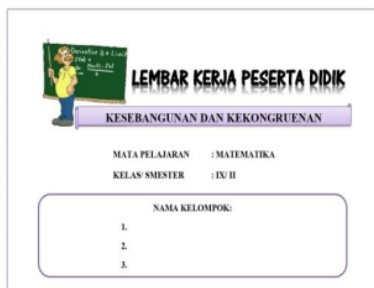


Figure 1. Cover Of Worksheet

E. Ringkasan materi Kesebangunan
 Dua bangun atau lebih dikatakan sebangun jika memiliki sudut-sudut yang bersesuaian sama besar serta panjang sisi yang bersesuaian memiliki perbandingan yang sama. Kesebangunan disimbolkan dengan ~.
 a. Syarat Kesebangunan Bangun datar
 Dua bangun datar dikatakan sebangun jika memenuhi dua syarat:

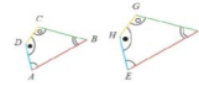


Figure 2. Summary

PERMASALAHAN 1

Amanda ingin mengukir lebar sebuah sangi yang mengukir ke arah utara, ia menancapkan beberapa bendera di tepi sangi. Bendera A dan B ditancapkan di tepi kiri sangi, bendera C dan D ditancapkan di tepi kanan sangi dengan jarak $AB = CD = 20m$. Kemudian bendera E ditancapkan ke arah timur dari bendera C, dan bendera F ditancapkan di tegak-terang CD. Hitunglah lebar sangi tersebut!

Financing or Objective-Finding (menemukan visi atau tujuan)
 Apa yang menjadi tujuan dari permasalahan diatas?

Figure 3. Problems

36 **3.2 Focus Group Discussion**

At the focus group discussion stage, the researcher and the teacher examined the weaknesses of the designed worksheet and made predictions of alternative answers to students. The results of the focus group discussion obtained several things that need to be improved which is as follows:

Table 1. FGD Result

Aspects	FGD Results
Identity	<ul style="list-style-type: none"> The identity of the worksheet was changed, firstly the identity only contained subject, class and semester, then education units and subject matter were added. The group name column was changed to the student's name so that the worksheet can be used independently or in groups. Revise the direction to work on the questions
Summary	The material summary was made more structured, more systematic and referred to

	basic competencies
Problem 1	The image in problem 1 should not be displayed. The purpose of removing the pictures is so that students can reason to make their own sketches
Problem 2	<ul style="list-style-type: none"> The dots in the problem 2 need to be fixed. Dots writing must be cyclic. The use of the word "side length 18cm" should be corrected
Problem 3	The image in problem 3 should not be displayed. The purpose of removing the pictures is so that students can reason to make their own sketches
Language Editorial	<ul style="list-style-type: none"> Make sure that the students understand the term "regularity" Revise the writing mistakes, use the correct EYD (spelling) Use sentences that are easy for students to understand
Construct	The colors used in the design should be adjusted
Whole	<ul style="list-style-type: none"> Questions at the stage of <i>idea finding</i> should be more summarized and to the point, with a maximum of two questions Editorial questions on the <i>solution finding</i> stage must be corrected

From the results of the focus group discussion, it was found that there were some changes, especially in problem 1, problem 2, and problem 3. Table 2 shows problems were tested on students.

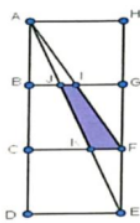
3.3 Trials

The next stage was trials, observation, and interviews. This stage aimed to determine whether the worksheet that has been designed can be used by students, as well as to find out the difficulties experienced by students when working on the worksheet. The results of the draft were then tested on 3 research subjects with initials namely JJ, IP and MA. After observing, the subject resolved the given problem on students' worksheets, then a direct interview was

conducted on the answers that have been done. Interviews were meant to know mistakes, difficulties, and students' perceptions of the problems that have been solved.

Table 2. Problems Were Tested On Students.

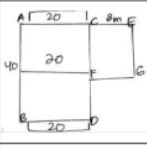
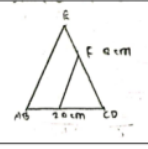
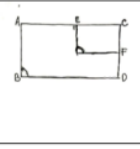
No	Questions
1	Amanda wanted to measure the width of a river flowing northward, she planted several flags on the riverbank. Flags A and B were planted on the left bank of the river, flags C and D were planted on the right side of the river with a distance of $AB = CD = 20$ m. Then flag E was planted 8 m to the east of flag C, and flag F was planted in the center of the CD. Calculate the width of the river.
2	It is known that three congruent rectangles with sides of 18 cm are arranged as in the image below. Calculate the area of the IJFK
3	It is known that the OPQR isosceles trapezium with a length of $OP = 8$ and $QR = 12$ cm. If point S is the midpoint of PR and T is the midpoint of OQ. Find the Length of the ST.



3.3.1. Problem 1

From the test results on three subjects, information was obtained that the subject JJ answered carelessly. This can be seen from the answer. JJ subject made sketches that were not relevant to problem 1. Apart from other questions, it can also be seen that JJ did not master the concept. JJ did not master the concept of angles, side concepts and congruence. Subject JJ also did not pay attention to the CPS-based escort questions that led to finding patterns. Subject JJ only recognized the written information on the problem. Slightly different to Subject JJ, Subject IP also experienced the same problem. He understood all the terms that existed in the problem but he still could not represent the problem in sketch form. Although not correct, the sketch shown by IP has led to

the problem. In addition, the IP subject understood the concept of angles and side. This can be seen from the students' answers and the following interview excerpts.

		
MA's Answer	JJ's Answer	IP's Answer
	<p>1. Perhatikan gambar yang telah dibuat. Apakah terdapat sudut-sudut yang bersesuaian? Bagaimana besar sudut tersebut, apakah sama? Jika iya, tuliskan pasangan sudut tersebut!</p> $\frac{E}{F} = \frac{AB}{AB} = \frac{CD}{CD}$ <p>2. Apakah terdapat pasangan sisi-sisi yang bersesuaian? Bagaimana tersebut, apakah sama? Coba perhatikan lagi panjang sisi-sisi tersebut dengan perbandingan panjang sisi-sisi tersebut? Apakah sama? Jika pasangan sisi-sisi tersebut!</p> $\frac{EAB}{FAS} = \frac{ECQ}{FCQ} = \frac{AQCQ}{AQCQ}$	
	JJ's Answer	

3.3.2. Problem 2

From the results of trials, problem 2 to three subjects, it can be seen that Subject JJ and IP understood the meaning of the problem presented. Subjects JJ and IP only knew written information. Subject JJ and IP knew that there were three shapes that were the same, but they had not been able to identify the implied information from the image. Subject JJ has not been able to see that in problem 2 there were other flat shapes, namely the triangle and trapezoidal shapes. Subject JJ had not been able to see that there were still triangular shapes that have the same shape but different sizes. This can be seen from the students' answers and the following interview excerpts.

<p>Visionizing or Objective-Finding (menemukan visi atau tujuan) Apa yang menjadi tujuan dari permasalahan di atas?</p> <p>Menghitung luas daerah JFEK</p>
<p>Fact-Finding (menemukan fakta) Informasi apa saja yang diberikan pada permasalahan di atas?</p> <ul style="list-style-type: none"> - tiga buah persegi panjang dengan - panjang 20 cm dan 10 cm

Figure 4. Student's Answer

3.3.3. Problem 3

From the results of trials, information was obtained that Subject IP knew the information from the questions and can sketch the problem well. It was just that he had not been able to see that there were flat shapes that had the same shape and size, there were also flat shapes that had the same shape but different size. Unlike Subject IP, JJ can be categorized understood the problem number 3. However, he was still doing wrong in solving it. The cause of this mistake was the imperfection of the previous concept. Subject JJ knew the meaning of the midpoint. But when being asked to solve the problem, JJ was still wrong in placing the middle point. This can be seen from the answers of Subject JJ and the results of the interviews.

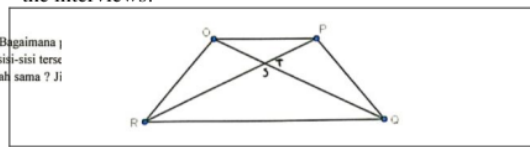


Figure 5. Student's Answer

Table 3. Interview Result

	Ok, let's move on to problem 3. From the structure of the question, which part that you do not understand?
J	Well, in this question, I am confused to find ST.
	In the problem, it has been explained that point S is in the middle of PR, so where should you draw point S, JJ?
J	in the middle, ma'am, in the middle of the PR line.
	then, point T is located in the middle of OQ. So where should you draw point T?
J	oh yeah ma'am, it should be right there, in the middle of the OQ
	well, so you found the ST line, right?
J	Oh.. Yes, ma'am.

3.4 Retrospective Analysis

The final stage was retrospective analysis. At this stage all the findings in the study were analyzed and then used to improve student worksheets. From the findings, it was found that all students understood the problem textually, but did not understand it contextually. Students can not sketch because they did not understand the situation presented in the problem. Students had not been able to identify all implied information. This was because students only focused on what was written in the problem. Students were not able

to identify the same elements and different elements, where the similarities lie and where the differences lie. Yet, all of this is the main key in finding patterns. In addition, students also only answered improperly from the guide questions and sometimes answered immediately without paying attention to what was asked of the guide questions. This was due to student habits. In addition, according to the students, the questions presented were too general and less specific, too difficult and abstract. So it needed to be slightly revised so that the student worksheet can actually lead students to practice finding patterns.

Pattern observation is a condition in which students realize that there are unique patterns or rules that appear as a result of the search for the problem solving strategy they choose [14].

From the research result, it can be seen that there are still student who are unable to find patterns. It happen because of the students only understood the problem textually, but did not understand it contextually. As a result, student cannot find solution to the problem given [26]. Based on the finding, students still could not represent the problem in sketch form. Subject new that there were three shapes that were the same. Students were not able to identify the same elements and different elements, where the similarities lie and where the differences lie. It is because of student didn't have some information from the image [27],[28]. Students had not been able to see that there were flat shapes that had the same shape and size, there were also flat shapes that had the same shape, but different size. Subjects only knew written information [29]. In general it can be conclude that the students was understood the problem textually, but did not understand it contextually. The subjects did not examine implied and expressed information deeply when solving a problem, and that subjects were not able to identify the same elements and different elements, where the similarities lie and where the differences lie. Yet, all of this is the main key in finding patterns.

4. CONCLUSION

Based on the results of data analysis, the designed student worksheet was generally categorized good both in theory and based on the results of the focus group discussion, although a little revision was still needed before it was tested at the trial stage. From the results of trials and observations, it was concluded that there were students who did not understand the meaning of the questions presented in the student worksheet. This can be seen from the answers written by students on the worksheet. The information written by students was irrelevant to the information on the problem and was

was less relevant to the questions asked. However, after tracing from the interview, it was found that the cause of the unsynchronized question and answer was due to the fact that the language used was not in line with student perceptions and was considered too abstract for some students. From the results of the answers it was also seen that students did not examine implied and expressed information deeply when solving a problem.

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