USING CIRCULAR PROBLEM POSING TO ENCOURAGE STUDENTS' IN SOLVING PROBLEMS OF MATHEMATICS

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui kreativitas siswa dan mendorong dalam memecahkan masalah matematika. Dengan studi observasional, topik peluang diujikan dan informasi dikumpulkan dari siswa SMA untuk mengetahui faktor yang mempengaruhi kreativitas siswa dalam pengajuan dan pemecahan masalah. Ada dua tahap untuk mengamati kreativitas: yaitu, generatif, dan eksplorasi. Kreativitas ditinjau dalam makalah ini adalah kreativitas berbasi Model Geneplore; ada dua fase, yaitu imajinatif dan memproduksi. Untuk mencapai aktivitas memproduksi, pengajuan masalah dilanjutkan ke pemecahan masalah. Variasi pertanyaan yang diajukan dengan menggabungkan munculnya 3 angka, 2 gambar, dan 2 gambar dan 1 angka mendorong berpikir kreatif siswa. Dengan kata lain, orisinalitas dan kepraktisan untuk masalah muncul. Pengalaman belajar dan pengetahuan dalam bentuk ini digunakan ketika mereka diberi tes untuk menguji sejauh mana pemahaman yang diperoleh setelah belajar. Akibatnya, ide-ide baru muncul ketika konteks masalah tertentu yang melibatkan satu atau dua dadu, karena aktivitas yang terlibat dalam konteks 3 koin dan efek konteks dengan 2 koin juga mengarahkan siswa untuk mencipta ide-ide baru lainnya.

Kata kunci*:* *Pengajuan Masalah Melingkar, Pemecahan Masalah, Matematika.*

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ABSTRACT

This study aims to recognize students' creativity and to encourage it in solving mathematics problems. By observational study, probability topic was examined and information was collected to senior secondary graders to find factors influence students' creativity in posing and solving problems. There are two phases to observe creativity: namely, generative, and exploratory. Creativity is reviewed in this paper is creativity based Geneplore model; there are two phases, namely imaginative and producing. To be achieved as producing activities, problem posing forwarded to problem solving. Variations in questions asked by combining the emergence of 3 numbers, 2 figures, and 2 figures and 1 number encourage students' creative thinking. In other words, originality and practicality to the problem emerged. Learning experience and the knowledge that this form was used when they were given tests to examine the extent to which the understanding gained after learning. As a result, new ideas emerge when the context of a given problem involving one or two dice, because the activity is involved in the context of 3 coins and the effect of the context with 2 coins also lead students to create new ideas other.

Keywords: *Circular Problem Posing, Solving Problems, Mathematics.*

INTRODUCTION

Mathematics as an intellectual domain stands at or near the top of any hierarchical list of intellectual domains ordered according to the extent to which creativity is evident in disciplinary activity or production. Learning mathematics not only needs to save the mathematical concept then it is used to apply to the problems related on it, but also supporting the next lesson in order to construct new comprehension. Building new understanding becomes the uneasy one for common students. This is the reason why mathematics is still debatable for how to facilitate students in their learning process such that meaningful and enjoyable activities.

Creativity as the evidence of learning result becomes hard challenge to students who will be observed their concrete abilities. In the other words, it is difficult for many teachers to encourage students to exhibit their creativity, especially for learning mathematics. When we discuss about cognitive domain of Bloom taxonomy, create is in the highest level for cognition ability. The main point of creativity is the action for turning new idea and imaginative creation into reality. Creativity is characterized by the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomena, and to generate solutions. Talking about learning mathematics, creativity is constructing the new idea using mathematical concepts that the users obtained and applied for a number of mathematics learning activities. Underlining the new idea in this definition, it means that students can show their own thinking to solve the given problems.

Showing new idea is the activity that is in line with creativity involving two processes: thinking, then producing. If you have ideas, but don't act on them, you are imaginative but not creative (Sternberg & Lubart, 1999).

Finding or posing problems is a quintessentially creative endeavor (Dillon, 1982). Whether the found problem is the presence of a hole in the ozone, or that people who smoke are prone to cancer, those keen enough to call our attention to them distinguish themselves by their astuteness. They help set community agendas that lead to discoveries and inventions that help make the world better.

Ellerton (1986) compared the quality of problems made up by high achieving math students with that by low achieving ones. The more able students made up more complex problems, could solve them, and could communicate about them better in conversation. The author viewed made-up problems as a tool especially suited for talented students. Also, such problems could serve a diagnostic purpose, if used to find out what a student believes is difficult. Asking children to make up their own problems was a way around the structured, passive framework that exists in many classrooms. Students could converse with each other about the problems they created.

Boosting creation in mathematics learning can be adapted by promoting creative thinking to produce problems of mathematics and to tackle the obstacle on it by constructing possible solutions. Like problem posing, along with problem solving, is central to the discipline of mathematics and the nature of mathematical thinking (Silver, 1994). When mathematicians engage in the intellectual work of the discipline, it can be argued that the self-directed posing of problems to be solved is an important characteristic (Polya, 1954). Mathematicians may solve some problems that have been posed for them by others or may work on problems that have been identified as important problems in the literature, but it is more common for them to formulate their own problems, based on their personal experience and interests (Poincare, 1948). Students who are mathematically promising need to go beyond problem solving to problem posing and finally to creating mathematical problems (Lin & Leng, 2008).

Following this theoretical review, behind of posing problems based on the situation given to students' activities can be found creative thinking; even they can construct better solution to solve the problems. Studying the experience of classroom observation, there are two things that the facilitators of mathematics lesson should know. The first thing is how the creative thinking appear from students' work, and what we should concern in order to keep maintain the creative thinking?

Getting started from those two concerns, this article exhibits some facts taken from classroom research and focus on what kind of creativity can be seen from creative thinking of students who pose and solve problems on math. Also, the explanation of examples could be well experience to share better information about the importance of maintenance activity to support creativity.

RESEARCH METHOD

Central to the idea of problem posing is the conception of students as interactive, social learners involved in the project of knowledge creation (Friere, 1970; Gregson, 1994; Wallerstein, 1987). Harnessing problem posing to encourage students of reconstruction from their old knowledge to new one, it can establish creativity.

According Torrance Test of Creative Thinking (TTCT) (Torrance, 1966; 1974) that have frequently been used to assess the creative of children and adults, the three key component of creativity assessed are fluency, flexibility, and novelty. Fluency refers to the number of ideas generated in response to a prompt; flexibility to apparent shifts in approaches taken when generating response to a prompt; and novelty to the originality of the ideas generated in response to a prompt.

Similar to the definition of that creativity is obviously to do with producing something original. But there are different views of what is involved in this process and about how common the capacity for creativity is (National Advisory Committee, 1998). The core of creativity is producing something colorful to wrap the old one into something that is different, after thinking process. This argument deals with "Geneplore" model, in which creativity takes place in two phases: generative phase and exploratory phase (Finke et al., 1992). In Finke's experiment of discovering creative inventions (Finke et al., 1999), subjects are required to combine separate object parts into one structure, and all those combinations are named preinventive structures, and they are judged by two criteria, including originality and practicality.

Generative processes are in terms of generating preinventive forms, examples include memory retrieval, mental synthesis, mental transformation, and categorical reduction (Lin & Leng, 2008). There are two types of generative processes, including intentional generation of preinventive forms and spontaneous generation of forms. Intentional strategy of generating preinventive structure involves deliberately control, while spontaneous generations are not ideas arose consciously, but those come up with one's natural intuitions.

Exploratory processes refer to the interpretation of creative structures, such as thinking of a chair in terms of its basic geometric shapes. Examples include functional inference, hypothesis testing and searching for limitations. There is also a distinction between intentional strategies for exploring preinventive forms, and manipulating forms without conscious control. Finke use problem solving process to explain differences between conscious and unconscious exploration of solutions, and encourages the emergence of relevant structures, or incubation of problem solutions (Lin & Leng, 2008).

To produce something original needs to construct meaning from what they learn, in ways that are consonant with and lend coherence to their experience, and that cognition of producers serve experiential world rather than any discovery of an ontological reality. Meaning that students create as a result of classroom experiences are moderated by complex communications organized within social roles. Knowledge is an adaptation and a function of personal history. Thus, what students come to know will likely be different from what teachers intended (Osborne, 1996, Phillips, 1995; Wheatley, 1991).

By observational study, some mathematical topics were examined and information was collected to secondary graders to find out what kind of creativity can be seen from creative thinking of students who pose and solve problems on math; what kind of mental representations that an individual constructed when we are talking about certain contexts. Then, those structures are used to come up with creative ideas. So, considering the purpose of learning, it is needed to keep on the importance of maintenance activity to support creativity is.

RESULT AND DISCUSSION

Apperception or brainstorming is very important in a learning activity, even using geneplore model, known as the generative phase. For this phase, knowledge is constructed by building a learning experience to learn about a given topic. To facilitate the learning activities are carried out, one of the topics that learned is probability. Activities designed are to understand the problem of probability for high-school level.

Having Geneplore model, we try to explore the creative thinking process about topic probability. The picture below shares information about how student who is given mathematical problem of probability showed their idea. Using understanding that the student has after learning the example of the topic given by their teacher, he tries to construct a mathematical problem.

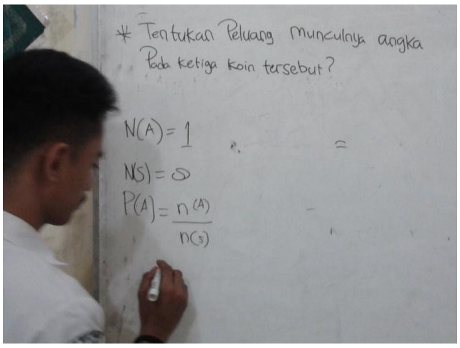

Figure 1. First problem given by his friend and he tried to answer

This picture shows us the way of student's thinking in order to solve the problem given by his friend. What kind of problem that he tried to solve is "find out the possibility of number would appear for three coins?" To obtain the solution properly, some information were identified such as the number of event A and sample S. Using conceptual plan of probability expressed with P(A) = , then P(A) is ….

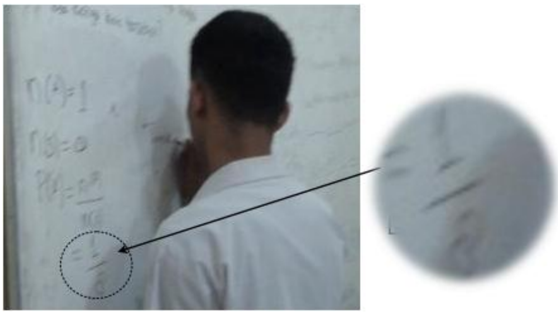

Figure 2. Steps to answer the first problem

So, the probability of number appear after toss is . We found this idea as the final answer which he explained that there is only one event from 8 sample point would be appeared during tossing the coins.

Following this activity, the student was instructed to make another related problem, as example showed in this picture. The notion of fluency, flexibility and novelty were observed as the indicators to indicate student's creativity. Beside that we also observed what have emerged during generative and exploratory phases.

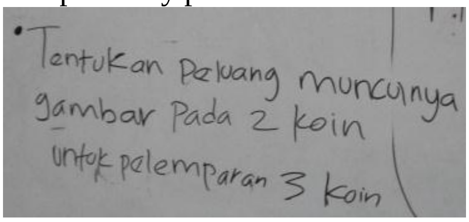

Figure 3. The Second Problem

Looking at the picture that the question is written which the students replaced number with figure, as we know only two sides can be found for the coin. The process of replacement from number to figure in this case we called apart of thinking process, then what emerged in that picture is the result of that thinking. so the question is varied, as is apparent from the questions that made the difference by using the "appearance of images on the 2 coin". To ask a question like this not only requires knowledge in the making, but an understanding that must underlie variations appear question is like this image. An understanding as to what is the understanding of the concept of chance, a component related to the concept, such events, the sample chamber and its members.

However, the question is then modified as in the image below. According to fixing the sentence so as not to repeat the word coin 2 times, another consideration is the coin that is used as much as three coins, two coins instead though that meant there was a picture that appears on the two coins from the 3 available.

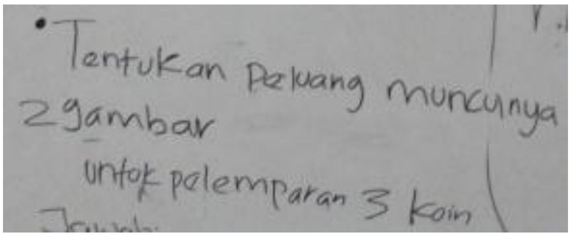

Figure 4. Revised Second Problem

Now, if this question has been understood by other students, of course, depend on the category solvable or unsolvable that question. Solvable meaning that other students can demonstrate mathematical concepts can clearly answer the question, otherwise unsolvable means although it can be answered, but if not using mathematical concepts, it can be concluded that the question was not answered by knowledge of mathematics. Activity was continued where after the students first had to answer questions that previously provided by his friend and this time he again makes his matter and also given the chance to finish it. To determine and ensure that the problem that has been created is solvable or unsolvable, pay attention to the work of another student in the image below.

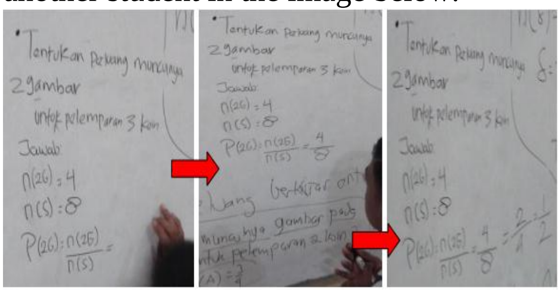

Figure 5. Another student tried to answer the second problem after revised

As it is expected, students will use mathematical concepts in preparing the solution of this problem, precisely the concept of probability. Of the answers given it appears that the students started by identifying the completion of many events in question and many members of the sample space, for example n (2G) = 4 and n (S) = 8. So, P(2G) = = = = . Because the answer given is correct and the information submitted in accordance with that of the problem means this student's work is solvable. The better a math problem that made at least can be solved by using mathematical concepts anyway. Therefore, it takes experience and knowledge to make a good problem. In other words, if a student can make a mathematical problem which can be solved by others, at least the students have the knowledge to construct the desired issues.

Fewer number of students included in this study makes it possible to rotate them in creating their own math problems. By rotating all students to take turns to create questions after brainstorming intended that they get the learning experience and the knowledge that forms can be practiced. The picture below shows a third student had a turn to write about the chances like two friends earlier.

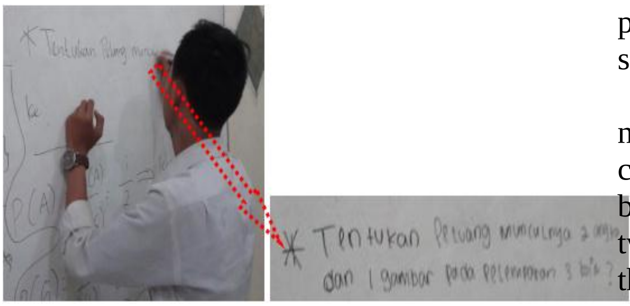

Figure 6. One of students tried to construct mathematics problem

The phrase "Find out the probability of apparent…" to be the standard of the three students who came forward to the front of the blackboard as the beginning of the problems they pose. Compared with the question posed by the second student, a problem which made combining the numbers and images includes 2 numbers and 1 image. The difference with the two students earlier, these students do own questions that are made with the understanding that the reason for the test held after the brainstorming.

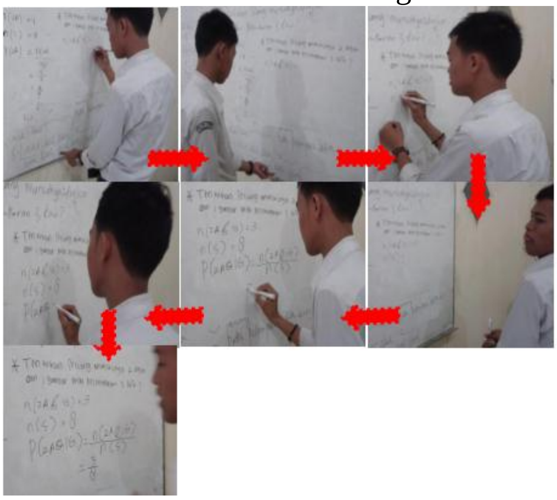

Figure 7. Steps to answer the seventh problem

Those pictures above are a compilation of what happens when the process of constructing a third student answers. As pictured top left, after completing the self-made problem, the next step is to solve the problem yourself. Of the image can be seen that the student is trying to identify the events referred to in the question are made. By calculating the results of the possible combinations appear in the sample space throwing three coins.

It did not seem easy to continue n (2A & 1G), the process of constructing answers had been halted because the student was confused by two numbers and one image. He argued that members of the sample space in the question are that has two numbers and one image. Of course, not only confused but also have difficulty in these words. Difficulties caused by the need to separate the figures and images, while the issues being discussed is a sample of events must meet the criteria, ie two numbers and one image. In order not to be confused, the step taken is to register all members who were in the sample space, including AAA, AAG, AGA, GAA, GGA, GAG, AGG and GGG. By doing so, the keywords two numbers and an image can be identified by matching these criteria with members in the sample space.

After registering all members who are in the sample space, he then identify intended by the given problem. This list also is useful so that the next step can proceed. The third and fourth images above show how he wrote n (2A & 1G) of 3 and n (S) as much as 8 so the probability of event is determined by the formula of probability (2A & 1G) = = .

Based on the description above results it can be argued that there are two phases that occur in the expression of students, that is, before writing and the time of writing. Phase pre-writing is a process in which the student will connect the knowledge and understanding of the context of the problem being discussed. However, knowledge is affected by the learning experience of others in which another student's work to be an example for him. The works of others is a learning experience of others and also themselves shaping her knowledge, mental representation, filling its memory, associated with information in his memory, or form a new structure, known as the generative phase.

The next phase of the time of writing, we see from the picture shown above where they were after interpreting a given problem. Then identify the target of the problems with determining the required components. For example, many events and many members of the sample space, it is not easy to determine based on the problems created by their own. Each student creates problems for other students’ means that every student should have the knowledge possessed by the students who make the matter. Each test happens in this kind of learning activities so that students are not directly share knowledge; ask each different problem, this activity is called circular problem posing.

According to Ward et al. after the exploratory phase generative phase is used to explore the structures resulting from the generative process, namely interpreting the structures from the perspective of the problem is resolved, and finding different ways or conceptual constraints suggested by the structure.

Pulling the description of this study is the culmination of several experiences that are formed with a variety of different issues that are expected to complete the combination of students' knowledge. In other words, compilation problems began with the emerging opportunities are all numbers, 2 images, and 2 images and 1 number for throwing three coins. The extent of the effect of this circular problem posing affects student learning outcomes. For the next activity is to provide a number of problems to be solved, look at the picture below.

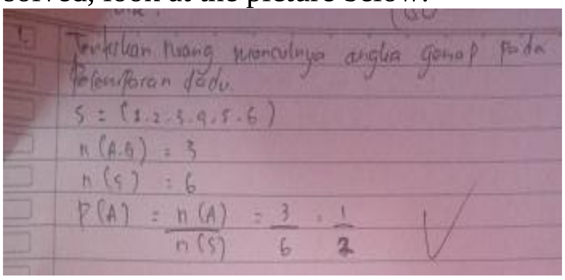

Figure 8. The first sample of student’s answer

The first problem is that "Determine the chance appearance of even numbers on the toss of the dice?" From the first issue is seen that the student in question is not difficult to construct its completion. Creative things done with the aim to help in determining how many events referred to in the question, as well as many members of the sample space or a lot of events that may occur. For example, a member of S = {1, 2, 3, 4, 5, 6} and because there are a lot of even number 3, then n(A.G) = 3. It can easily be determined many members in the sample space is 6 so P(A) = = = .

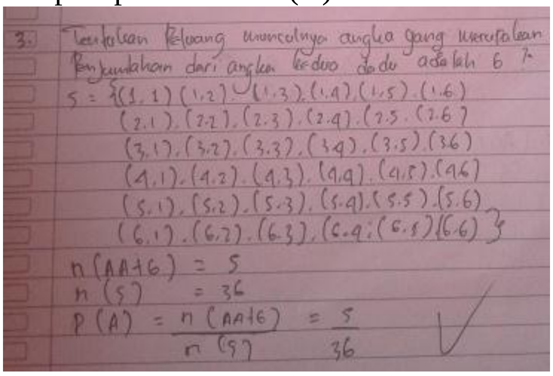

Figure 9. The second sample of student's answer

One dice and two dice have members of different sample chamber so that the level of difficulty for problems involving the dice and two dice are also different. Not infrequently often have a misunderstanding about the sample space members; often students answer 12 because they add members of the sample on the first dice and a second dice. Though it is still very little when the dice a few times and the right results for the second toss of the dice is 36. This understanding has been identified by students can be seen from the answers given, he wrote as shown below.

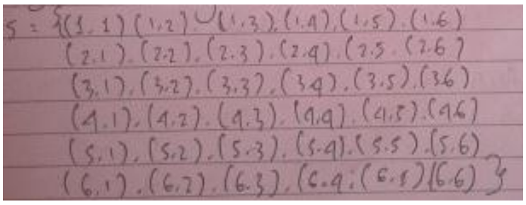

Figure 10. One of some steps that student used to construct his answer

How to register members of the sample space as this picture may not be new, but logically and mathematically he can show anything that fills the sample space for two dice. This method makes it easier to construct a settlement step in determining the probability of the emergence of the sum of the two dice numbers are 6.

For the fourth problem, the challenge faced by students is to understand the words "at least 1 number". Surely this matter is very different to what they have done in previous brainstorming sessions where students are expected to know at least 1 number means the sample chamber members that have the numbers. What kind of student's work, one of which is shown in the figure below.

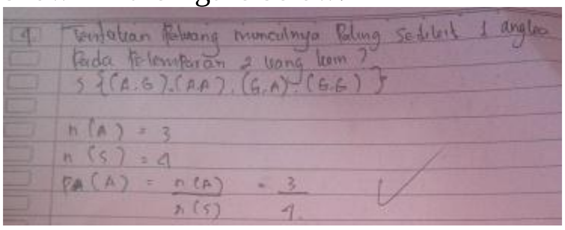

Figure 11. The third sample of student's answer

Predictions suggested that if students do not understand the given problem is not right. Similar strategies are applied back of identifying members of the sample chamber. This step is an effective introduction to assist in solving a given problem. Therefore, the answer given is correct, ie .

Learning from what Finke et al., (1992) suggest about Geneplore models, to identify what kind of creativity that is expressed as a form of creative thinking is divided into two parts, namely the problem posing and problem solving. When students are asked to apply mathematical problems with the topic of opportunities, it can generally be done either because the examples given had limited knowledge of them in making the matter. This is evident from the first word is used, such as "define the emergence of opportunities." However, the continuation of that sentence and turns variation interesting question lies in the continuation of the sentence, such as the emergence of the three numbers on the coins, the emergence of two images to toss 3 coins , and the rise of 2 images and 1 number in 3 coin toss.

Generating question after question created itself also affects the way students in solving those problems. Increased levels of questions also influence the development of knowledge of learners that can be seen from the way they solve, but the emphasis is on what is needed and created before they execute formula of probability. Then the process has become a mental representation of the imagination of a growing problem posing. In other words, the question was changed, imagination turns, then step settlement was also changed. This is called the originality and practicality of the two processes, namely imaginative and producing.

CONCLUSION

The next phase of the time of writing, we see from the picture shown above where they were after interpreting a given problem. Then identify the target of the problems with determining the required components. For example, many events and many members of the sample space, it is not easy to determine based on the problems created by their own. Each student creates problems for other students' means that every student should have the knowledge possessed by the students who make the matter. Each test happens in this kind of learning activities so that students are not directly share knowledge; ask each different problem, this activity is called circular problem posing.

Another way to indicate the creativity of students is to ask them to show the ideas contained in their minds. One learning approach that is able to do so is a circular problem posing. The difference with the other problem posing is each student was asked to submit questions that will be done by another friend. In other words, about the proposed their friends who then given to other students to answer.

Creativity is reviewed in this paper is creativity based Geneplore models, where there are two phases, namely pre-writing and time of writing, or imaginative and producing. To be achieved as producing activities, problem posing forwarded to problem solving. So, students will not only be able to submit questions, but also must be able to show completion. Other terms, imaginative without action, it is not creativity.

Variations in questions asked by combining the emergence of 3 numbers, 2 figures, and 2 figures and 1 number encourage students' creative thinking. Although the formula of probability are the ratio between the number of occurrences and the number of members in the sample space, the idea to determine the number of occurrences and the number of members in the sample space is new creations for the students. In other words, originality and practicality to the problem emerged.

Learning experience and the knowledge that this form was used when they were given tests to examine the extent to which the understanding gained after learning the circular approach problem posing and problem solving. As a result, new ideas emerge when the context of a given problem involving one or two dice, because the activity is involved in the context of 3 coins and the effect of the context with 2 coins also lead students to creative new ideas other.

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