ISSN 2355-4185(p), 2548-8546(e)
DOI: 10.24815/jdm.v10i1.29016

Creative Thinking Level of Students in Posing Conditional Probability Problems

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Received: 16 November 2022; Revised: 12 March 2023; Accepted: 20 April 2023

Abstract. *Mathematical creativity provides space for students to express their ideas. Hence, the mathematical activities should support their ability to pose and solve problems. However, students are not used to them and have difficulty in proposing and solving creative problems. The ideas proposed are in the form of problem-posing with free situational and semi-structural types and their solutions. This study aims to describe the level of creativity of students in problem-posing and problem-solving conditional probability problems. The research method used was qualitative, and participants were 35 second-year preservice mathematics teachers. The result indicates that, in posing a free situational type problem, students were generally at level 3 (creative) while, in posing a semi-structural problem, students were generally at level 0 (not creative). Although, the students in each type of problem-posing task were at the category of level 4 (very creative), level 3 (creative), level 2 (quite creative), level 1 (almost creative), and level 0 (not creative). This shows that there is a need for habituation for students to pose and solve problems, especially those that are related to semi-structural type problems.*

Keywords*: creative thinking level, flexibility, fluency, novelty, problem-posing*

Introduction

Creativity is a significant indicator of learning mathematics in various parts of the world. The importance of creative thinking is reflected in the last few decades which has shown a lot of research on the level of creative thinking and the importance of cultivating creative thinking skills in students (Cochrane & Heathcote, 2021; Sodirzoda, 2021). The need for creativity is following the demands of the global era which emphasizes the preparation of human resources who can survive and overcome problems in life. Through this ability, students can flexibly express their ideas and thoughts. Furthermore, creativity is often seen as a unique part of learners with unusual capacities and intellectual abilities (Oliveira, Brown, Zhang, LeBrun, Eaton, & Yemen, 2021). Derived from creativity is what eventually leads to innovation or new ideas as the result of students' thoughts.

Some of the problems experienced by teachers in developing student’s creativity such as heterogeneous student abilities, erroneous perceptions regarding students’ learning outcomes using teacher-centered learning strategies, no adequate teaching experience in developing thinking skills such as creativity, and time-consuming for teachers to develop student’s creativity (Sukardi, Sopandi, & Riandi, 2021). Based on the problems, teachers must be patient to deal with the dynamics of students in class due to the differences in comprehension levels. In addition, teachers must possess correct perceptions regarding learning outcomes and students' different abilities because this is very influential in learning specially to stimulate students' creativity. Therefore, teachers must determine appropriate learning strategies to provide opportunities for students to create new things as a result of their creativity. In line with this, (National Council of Teachers of Mathematics, 1991) states that: "…it must be given the opportunity to formulate problems from certain situations and create new problems by modifying the given problem conditions".

Creativity is one of the skills that can be cultivated through the process of mathematics learning. Mathematical creative thinking is a combination of divergent and focused thought that is based on intuition but has a conscious goal (Man, Wang, & Liu, 2021). Someone with the ability to think creatively can use his ideas to solve problems or pose new problems through investigations (Ayllón, Gómez, & Ballesta-Claver, 2016). The process of logical thinking is used to assess the right solution. A person's ability to pose a problem is a sign of creativity (Singer & Voica, 2015). Therefore, it shows a close relationship between problem-posing and creativity (Singer, Ellerton, & Cai, 2013) where in problem-posing, students examine, analyze, and write various problems using their original opinions and sentences (Hartmann, Krawitz, & Schukajlow, 2021). Accordingly, problem-posing can be a test of creative thinking.

Problem-posing activities have a positive impact on students' problem-solving abilities and thinking awareness (Akben, 2020). Due to its significance, problem-posing activities should be supported in the curriculum and education system in schools. The school curriculum must emphasize learning that focuses on giving assignments in the form of problem-solving and problem-posing which requires creativity (Bicer, Marquez, Colindres, Schanke, Castellon, Audette, Perihan, & Lee, 2021). Problem-solving is often seen as one of the skills that should be taught in math classes. Problem-solving consists of activities such as understanding the problem, devising a plan, carrying out the plan, and looking back (Chamot, Dale, O'Malley, & Spanos, 1992; Kang, 2015).

There are three problem-posing situations, namely free, semi-structured, and structured situations (Baumanns & Rott, 2021). In a free situation, students pose problems without boundaries (Bonotto, 2013). Whereas, in a semi-structured situation, students are given an open situation and are invited to explore the structure in that situation and facilitate them in using knowledge, skills, concepts, and relationships from previous mathematical experience. Then, in structured situations, students pose problems by varying existing situations so it requires high creativity (Baumanns & Rott, 2022). Problem-posing plays a role in determining student creativity (Azlina, Amin, & Lukito, 2018; Lee, 2021). Creativity is understood as the cognitive ability to create and discover. Meanwhile, problem-posing refers to producing or revealing something new from a set of data that requires creativity (Papadopoulos, Patsiala, Baumanns, & Rott, 2022; Sadak, Incikabi, Ulusoy, & Pektas, 2022). In line with this, other research shows that students can build a stronger understanding of mathematical content when they are engaged in activities that pose authentic problems that are meaningful to them (Kwon & Capraro, 2021) and allow freedom of expression (Bevan & Capraro, 2021). Thus, teachers need to incorporate directed and focused problem-posing activities into their learning process.

In this study, the proposed mathematical problem requires students to formulate queries or organize mathematical problems based on the provided information, and then solve the problems. Meanwhile, the focus of this study is to describe the level of creative thinking of students in generating "new" ideas and being as flexible as possible in posing a problem and solving it. Student problem-posing tasks are related to their creativity using three components of creative thinking including fluency, flexibility, and novelty (Ma, Bie, Li, Gu, Li, Tan, Tian, & Fan, 2021; Yuan, Lu, Jing, Yang, & Hao, 2022). Fluency in posing problems refers to student's ability to generate many problems with the correct solution. Flexibility in posing problems refers to students' ability to pose or build problems with different criteria. Novelty in problem-posing refers to students' ability to propose or construct problems that are different from others (Gisbtarani & Rianasari, 2021; Kwon & Capraro, 2021; Leavy & Hourigan, 2020). Students examine some of the problems posed and then propose problems with different contexts and concepts.

Other research shows a close relationship between creativity and problem-solving abilities (Chevalier, Giang, Piatti, & Mondada, 2020; Puccio, Burnett, Acar, Yudess, Holinger, & Cabra, 2020; Shao, Zhang, Zhou, Gu, & Yuan, 2019). In contrast to previous research, in this study, students' creativity was measured by their ability to pose and solve problems, especially regarding conditional probability. Based on the research background that has been described previously, the formulation of the problem in this study is how the level of students' creative thinking in posing conditional probability problems.

Method

This research is a qualitative descriptive research. This research was carried out offline in offline at a public university in West Nusa Tenggara involving 35 research subjects in the second semester of the mathematics education program who were taking probability theory courses. This study aimed to describe the creative thinking level in proposing and solving problems related to the probability theory. The data was collected by using a task in the form of open-ended problems for students to pose problems related to conditional probability and then solve them. The tasks used are problem-posing free situation problem tasks and semi-structural situation problem tasks. The first task (free situation problem task), students are asked to pose problems from situations that have been given, contrived or naturalistic (see Task 1 in Figure 1). While in the second task (semi-structural situation problem task), students are asked to pose problems based on the open situations given and they are invited to explore the structure of the situation, and complete it by applying knowledge, skills, concepts and relationships from their previous mathematical experience (see Task 2 in Figure 1).

Task 1. free situation problem task
Make as many problems as possible with conditional probabilities and then solve them.

Task 2. semi-structural situation problem task
Given that A is the event that an odd number is drawn
B is the event that an even number is drawn
C is the event that a prime number is drawn
D is the event that a number greater than 5 is drawn
E is the event drawn ....
F is the event drawn ....
If from $S = \{0,1,2,3,4,5,6,7,8,9\}$ a number will be taken at random, complete events E and F then create as many problems as possible using the information provided and then solve them.

Figure 1. Open-ended tasks given to students to assess students' creative thinking level

The task instrument was developed by the researcher together with the lecturers who teach the probability theory course. This instrument has been validated by experts from mathematics education lecturers with minimum criteria of a master's degree and at least 8 years of teaching experience. The results of descriptive content validation are in the valid category above 80%.

The problems submitted by students in task 1 and 2 were first assessed for suitability with the following conditions: (1) Problems that do not fit are omitted and not analyzed further (non-mathematical problems). In addition, problems that do not have enough information to solve are not prossessed further for creativity analysis. For example, for the second task, responses such as "Probability E with condition F" but the event E and F were not defined. The remaining responses were appropriate according to the rubric in terms of fluency, flexibility, and originality. Indicators of the level of creative thinking can be seen in Table 1 (Siswono, 2010, 2011).

Table 1. Indicators of creative thinking ability level

Level	Characteristics of Creative Thinking Level
Level 4 (*Very Creative*)	Students fulfill all components of creative thinking skills or only flexibility and novelty in asking and solving problems.
Level 3 (*Creative*)	Students are fluent and flexible in asking and solving problems or showing novelty in asking and solving problems.
Level 2 (*Quite Creative*)	Students show flexibility or novelty in posing and solving problems without fluency.
Level 1 (*Almost Not Creative*)	Students demonstrate fluency without novelty and flexibility in posing and solving problems.
Level 0 (*Not Creative*)	Students are not able to show any component of creativity.

Fluency, flexibility and novelty in Table 1 are explained as follows: (1) Fluency refers to the number of questions asked that can be solved correctly; (2) Flexibility refers to the number of problems that are posed with different structures or concepts correctly and can be solved correctly; and (3) Novelty refers to the number of problems posed by students, which differ by less than 10% from 35 students or less than 4 students who pose the same problem and can be solved correctly. This criterion is based on research by Yuan and Sriraman (2011).

The results of the tasks carried out by students are then analyzed and categorized according to the level of creative thinking using the criteria in Table 1. Then, from 35 students, 5 people are selected (each level of thinking has a representative) to be interviewed with certain criteria according to the level of creative thinking and several considerations of certain problems, such as the context of the problem raised is unusual or different from other students who show creative potential. The interview was conducted after the assignment was given. Before the interview began, students were asked to re-read the problems they had posed. The data collected was then analyzed using the stages of transcription, segmentation, coding, technique categorizing and conclusion drawings (Creswell, 2012). Data validity was carried out by triangulation of test and interview methods, as well as member checking.

Results and Discussion

The level of students' creative thinking is evaluated based on their solutions to the problems posed, and both solutions are valid. Students who pose problems with incorrect solutions are excluded from the creativity evaluation. Similarly, if the questions posed are inaccurate or lack complete information, but the answers provided are correct (due to the addition of certain events), this is not considered in the analysis to determine creativity.

From the task analysis of 35 students, it was found that the level of students' creative thinking ability was at five levels of creative thinking, namely, level 0 (not creative), level 1 (almost not creative), level 2 (quite creative), level 3 (creative), and level 4 (creative) where in each given task category, most students are at level 0 (not creative) for the semi-structural situation problem task and level 3 (creative) for the free situation problem task. Furthermore, the results can be seen in Figure 2.

Figure 2 shows that at level 0 and level 1, students pose a semi-structural situation problem task better than the free situation problem task. Whereas at other levels (level 2, 3, 4) students pose better problems in the free situation problem task than the semi-structural situation problem task. From the results of the open-ended task analysis, 5 subjects were selected to represent each level. Level 0 is coded S1, level 1 is coded S2, level 2 is coded S3, level 3 is coded S4, and level 4 is coded S5.

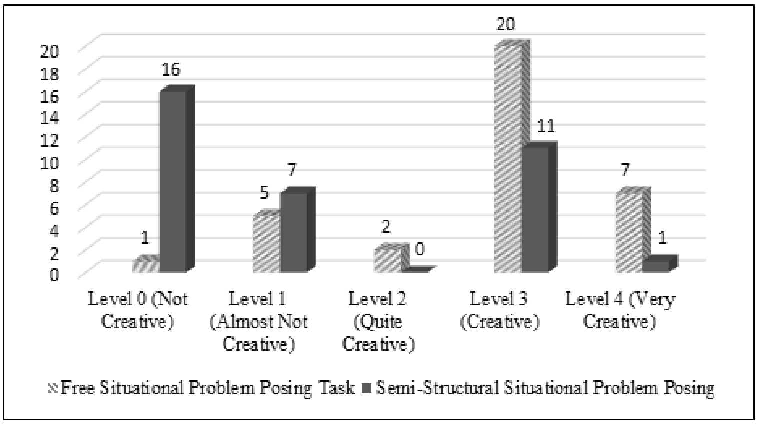
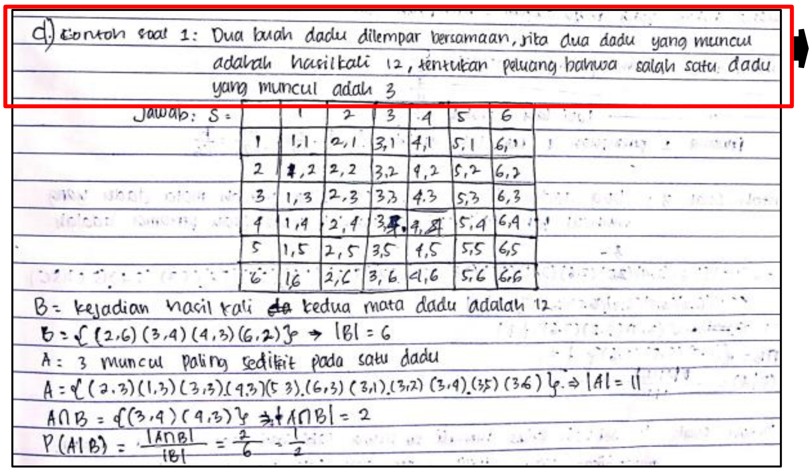


Figure 2. Level of creative thinking of 35 students in posing conditional probability problems

Student Problem-Posing at Level 4 (Very Creative)

Subjects at level 4 (very creative) were able to fulfill all the creative thinking criteria, namely fluency, flexibility, and novelty. The information contained in the questions posed is complete and correct, as well as the solutions provided. For example, in posing a problem task 1. free situation problem task which can be seen in Figure 3.



Translation
Two dice are thrown simultaneously. If the product of the two dice that appears is 12, find the probability that one of the dice is 3.

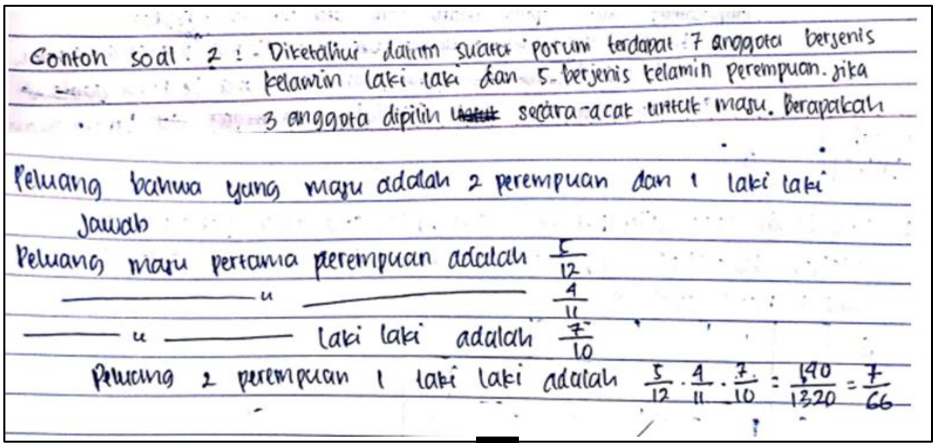
Figure 3. Problem-posing and problem-solving of task 1 free situation problem task by S5

S5 was able to ask 2 questions that contained complete information and was able to answer them correctly in task 1 (Figures 3 and 4). This shows that students have fulfilled the fluency aspect. S5 is also able to arrange questions using more than one different category as shown in Figure 4. Figure 4 shows that the questions posed by the subject fulfill aspects of flexibility because they use two different ideas or concepts, and S1 provides novelty in posing and solving problems where no other student poses the same problem as he posed. The following are the results of interviews with S1 subjects.

R	:	*What inspired you to pose this problem?*
S5	:	*I see from the examples of problems that I have seen before. I do and I answer*
R	:	*Is the problem exactly the same as the problem that has been seen before?*
S5	:	*No. I did a lot of modifications*
R	:	*What modifications did you make?*

S5	:	*I try to remember and understand in advance the examples of questions that I have seen before and I try to work on them. Then I modified the question to be like this (while pointing at the answer). I changed some of the sentences and information that was asked to make it different.*
R	:	*What was the process you went through in filing the problem?*
S5	:	*I started by making questions first by compiling the question sentences first after that I answered them. For the next questions, I will modify them from other questions that I have seen before.* *I like to make questions that are easy to understand and can be done. I want to make questions that are more difficult but I have difficulty making questions that contain distractors so in making questions, I only make questions that I can understand and solve by modifying previous questions into new questions by changing the choice of sentences or numbers known numbers.*
R	:	*Is the information in the questions that have been made complete? workable or not?*
S5	:	*I think it's complete because it can be completed so that the information I think is complete*

The interviews result showed that S5 made modifications by utilizing the knowledge he had acquired regarding conditional probability and questions he had found or had learned to create new questions. This shows flexibility and fluency in the problem-posing it does.


Contoh soal 2 : - Diketahui dalam suatu porum terdapat 7 anggota berjenis kelamin laki laki dan 5 berjenis kelamin perempuan. jika 3 anggota dipilih secara acak untuk maju. Berapakah Peluang bahwa yang maju adalah 2 perempuan dan 1 laki laki

Jawab

Peluang maju pertama perempuan adalah $\frac{5}{12}$

" $\frac{4}{11}$

" laki laki adalah $\frac{7}{10}$

Peluang 2 perempuan 1 laki laki adalah $\frac{5}{12} \cdot \frac{4}{11} \cdot \frac{7}{10} = \frac{140}{1320} = \frac{7}{66}$

Translation:
In a forum there are 7 male members and 5 female members. If 3 members are randomly selected one at a time to advance, what is the probability that the first and second are girls and all three are boys?
Answer:
The probability the first choice is a woman is $\frac{5}{2}$
The probability the second choice is a woman is $\frac{4}{11}$
The probability of choosing 2 women and 1 man is $\frac{5}{12} \cdot \frac{4}{11} \cdot \frac{7}{10} = \frac{140}{1320} = \frac{7}{66}$

Figure 4. Problem-posing and problem solving other problems from task 1 free situation problem task by S5

Student Problem-Posing at Level 3 (Creative)

At level 3 (creative), S4 can meet the criteria of fluency and flexibility but has not yet fulfilled the novelty aspect. In terms of fluency, S4 can pose 4 problems that contain complete information and can be answered correctly for task 2, while only being able to pose 2 problems and their solutions correctly for task 1. An example of problem-posing and problem-solving at level 3 is as follows.

If given $S = \{0,1,2,3,4,5,6,7,8,9\}$ and will be taken a number with
A: The event that an odd number is drawn
B: The event that an even number is drawn
C: The event that a prime number is drawn
D: The event that a number is drawn more than 5
E: kejadian terambilnya bilangan kurang dari 5
F: kejadian terambilnya bilangan faktor dari 12

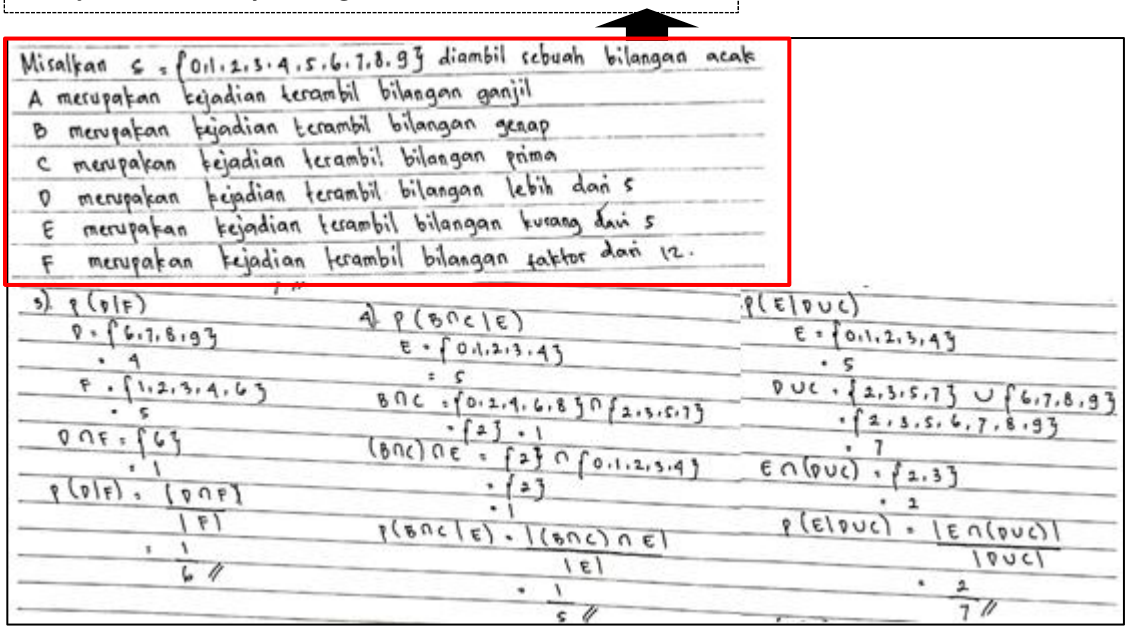


Figure 5. Example of answers to task 2 by S4 in posing and solving problems

Figure 5 shows that of the several problems that have been proposed by S4, the first problem is related to the probability of a conditional event consisting of two events. While the second and third problems are about the probability of conditional events using a combination of two events (combination of 2 events). However, the concept used is different, namely associating it with the combined and intersectional concepts of two events or sets. This shows that students are only able to make 3 different problems in terms of flexibility. Whereas, in terms of novelty, there are no new problems and solutions given because more than 10% of students pose problems with the same criteria. Furthermore, the following are the results of interviews with subject S4

R : *What inspired you to pose this problem?*

S4 : *I made a different question from the previous questions. I entered joins and intersections to include in the conditional probability question. I associated it with materials that I had studied at school and college regarding permutations and combinations.*
From the questions I've worked on, it asked the probability of an event with the condition of 1 event too, while there was no condition that it was a combination

of 2 sets or being the probability of two sets with the conditions of a certain set. Therefore, I tried to structure such a question and try to answer it. Apart from that, I also recalled the concepts or material that had been taught by my supervisor regarding conditional probability material.

R : *How do you check whether the problem or question you have prepared is correct or the information in the question is complete or not?*

S4 : *checked again the questions I made and the answers. If the answer is correct then the question is correct or the information needed to answer it is appropriate.*

R : *Have you ever worked on/solved questions like the one you made before?*

S4 : *Previously related to the union and intersection of two sets and the probability of the combination and intersection of two sets, I had studied it in middle school or high school, but I learned about conditional probability only when I was in college. So, questions like this are still new to me. For conditional probability questions such as P(D|F) an example was already given during lectures, but the incident was different from what I made.*

Student Problem-Posing at Level 2 (Quite Creative)

Subjects at level 2 (quite creative) were able to fulfill the novelty of the creative thinking criteria while fluency and flexibility could not be met. S3 is only able to pose one question that contains complete information and can be answered correctly. However, the answers given fulfill the novelty aspect because the problems and solutions given are different from other students. An example is the problem-posing of a semi-structural situation problem task which can be seen in Figure 6.

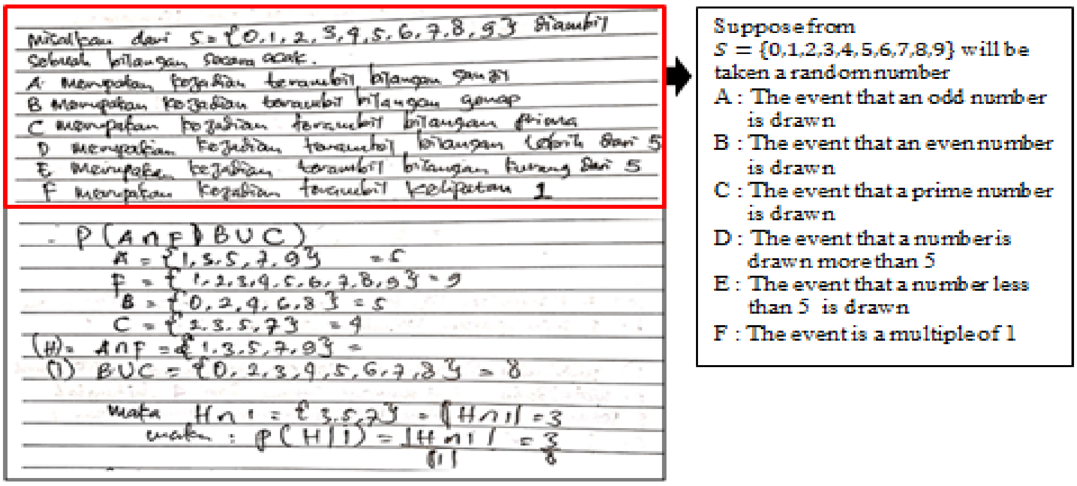


Figure 6. Example of S3's answer to task 2 in posing and solving problems

Figure 6 shows that in posing the problem, S3 combines the knowledge he has previously obtained related to the combination and also the intersection of two numbers. S3 creates this problem by experimenting by first compiling the problem and then he determines whether the problem he compiled can be solved or not. The problem posed by him is different from the problem posed by his colleagues. This shows that S3 can show novelty in the given problem-posing. S3 can also answer the problem it gives correctly including explaining it well. This can also be seen in the following interview.

R : *What inspired you to pose this problem?*
S3 : *I want to try to make a question that is different from the questions I have solved and at the same time try whether I can solve it or not. If I can't solve it, I'll move on to another question.*
R : *Have you asked or completed this question before?*
S3 : *Never. I just got it at that time. The problem is that I just made and worked on it at that time.*
R : *How did you proceed in asking these questions?*
S3 : *I prepared the question first, then tried to solve it, whether it could be solved or not, and then I wrote down the answer key. I tried several cases but I decided to make a problem that I'm not used to working on to be more challenging. This is also because I'm curious whether the problem I made can be solved or not.*
R : *How do you check whether the problem or question you have prepared is correct or the information in the question is complete or not?*
S3 : *I'll try to answer first. If I find the answer successfully, then the information on the question is complete. If I can't answer this question, there may be missing information or the wrong question and I will move on to making other questions. Apart from that, I also linked it to the materials I had received in lectures to check whether my answers were correct.*

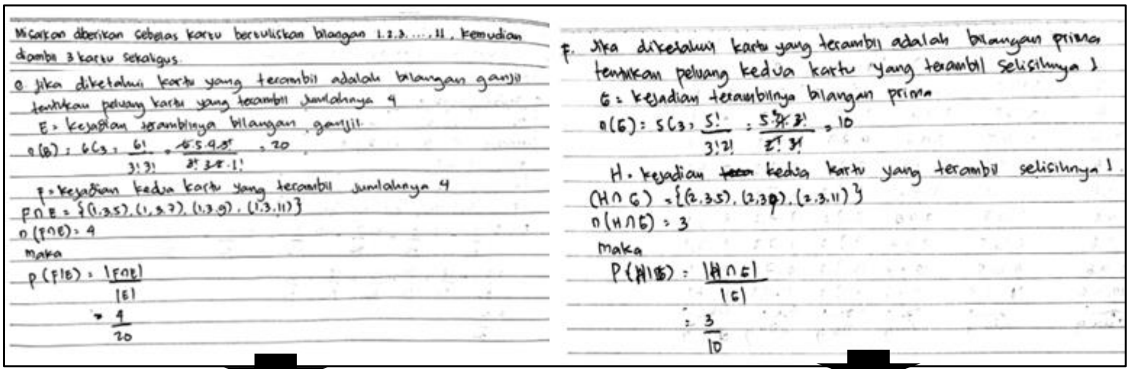
Student Problem-Posing at Level 1 (Almost Not Creative)

Subjects at level 1 (quite creative) were only able to fulfill the fluency criteria for creative thinking, while flexibility and novelty could not be fulfilled. The information contained in the problem-posing is complete and correct, as well as the solutions provided. For example, in problem-posing task 1. free situation problem task which can be seen in Figure 7.

From Figure 7 it is known that of the 3 problems and solutions given, there is 1 that does not match between the questions and the solutions so that 1 problem is not included in the analysis. From the results of the interviews it was found that in order to fulfill the fluency aspect, S2 made modifications from the previous questions he had made by exchanging information on other questions. This can be seen more clearly in the following interview.

R : *What inspired you to pose this problem?*
S2 : *After I select the number, maybe the number contained there will be somewhat less than the data I selected. For example, if I use a multiple of 3 then the data will have 3 or 4 data. If it's a multiple of 4 it's too little, if it's a multiple of 2 it's too much so I limit it to a multiple of 3 so it only has 5 data*
R : *Is the information from the questions you have made correct?*
S2 : *Something is not right between my question and answer. Question number 3, it says* $P(F|B)$ *but the answer says* $P(C|E)$.
R : *How do you know it's not quite right?*
S2 : *My answer should be in accordance with the question, but it seems that the third question that I asked is the same as the second question, so it seems that I wrote the third question wrong, the correct one should be* $P(C|E)$.
R : *How do you turn the asked question into a new question?*
S2 : *I thought that I could use other data but it was conditioned by the problem I had created. So, at that time, I made a* $P(B|F)$ *question... I also thought about changing the data on the left to become a condition so that it becomes* $P(F|B)$. *I wonder if have the same chance.*
R : *What is the process by which you ask these questions?*

S2 : *I prefer to structure the question first, and then find the solution on the doodle sheet. After getting the solution, I just rewrote it on the answer sheet for the question.*

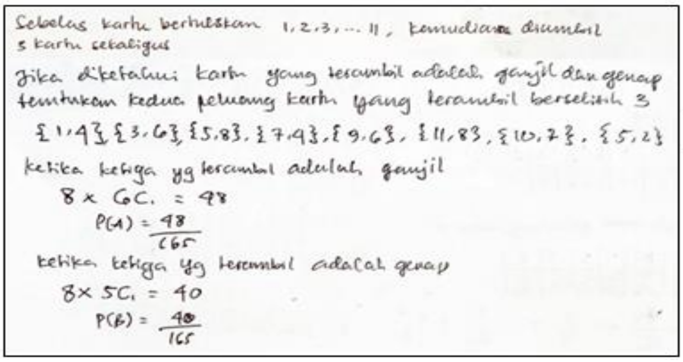


If you are given a card with the numbers 1,2,3, ... ,11 next to it, then 3 cards are taken at once. If it is known that the card drawn is an odd number, determine the probability that the number of cards drawn is 4 E: The event that an odd number is drawn F: The event that the two cards drawn add up to 4	If it is known that the card drawn is a prime number, find the probability that the difference between the two cards drawn is 1. G : The event that a prime number is drawn H : The difference between the two cards drawn is 1

Figure 7. Example of S2's answer to task 1 in posing and solving problems

Student Problem-Posing at Level 0 (Not Creative)

At level 0 (not creative), S1 pose the problem that contains incomplete information and some questions are made with solutions that are written incorrectly so that they are not included in the analysis of creative thinking. This shows that S1 does not meet the criteria of fluency, flexibility, or novelty. The following is an example of an S1 answer in asking task problem 1.



Eleven cards labeled 1, 2, 3, ..., 11 are then taken 3 cards at once. If it is known that the card drawn is odd and even, determine the probability that the two cards drawn are different by 3.

Figure 8. Example of S1's answer to task 1 in posing and solving problems

From Figure 8, it is known that the S1 subject was wrong in solving the questions he asked. S1 is also not sure about the correctness of the questions and answers he is working on. This can be seen from the following interview results.

R : *How did you process to pose the problem in the task 1 question? Can you explain the process for solving it?*

S1 : *So, if it is known that the card drawn is odd. The occurrence of the two cards that were drawn was more than 10 as I wrote. For example {(1,11), (3,9), ...,* *(9,11)} (pointing to the answer). When the three cards drawn are odd, this is the calculation (while indicating the answer), namely 9 × 6C1 = 54. Likewise, when the three cards drawn are even, namely 9 ×5C1 = 45. So ma'am.*

R : *Why is that?*
S1 : *Mmm, I don't know ma'am. I think so. But it seems wrong. There is still something missing (While thinking)*
R : *What are the conditions?*
S1 : *The cards drawn are odd and even. Looks like (Thinks). Sorry Mom, I don't know.*

S1 asks questions by modifying questions that have been asked before. The questions posed begin by posing the problem first and then determining the solution. The questions posed were questions that had previously been studied before. However, the questions and solutions given are still wrong in their completion. This can be seen from the following interview results.

R : *What inspired you to pose this problem?*
S1 : *t's just my own initiative, mom. I take any problem*
R : *Anything what do you mean?*
S1 : *I'll just make it free, Mom. The consideration is that I can do it.*
R : *What's the initiative like? Could you please explain what the process is like?*
S1 : *I made questions that were easy for me to understand and could do. I made questions with the same pattern by making a few modifications. This is so that it's easier because you only have to change a little, either from the questions or answers. I modified the question or the editor asked. But I'm not sure about the correctness of the answer I wrote.*
R : *Why is that?*
S1 : *I don't understand that material*

Students' creative thinking skills in posing mathematical problems can be seen for each level of creative thinking from the aspects of fluency, flexibility, and novelty in problem-posing. Students at the level of creative thinking level 4 (Very Creative) can fulfill fluency, flexibility, and novelty. This is because subjects at this level can pose reasonable problems with sufficient information about conditional probability and correct answers. The concept used from one problem to another is different by using different cases or modifying it by providing additional information. In addition, the use of related concepts and prior knowledge also plays a role in generating new questions as well as solving them correctly. These results are supported by the research conducted by Singer and Voica (2017) that problem-posing refers to the creation of a new problem, and also to the reformulation/modification of the given problem. The results of this study are also in accordance with the theory of Khoiriyah and Purwanti (2021) and Siswono (2010, 2011).

Level-3 students can only able to meet the criteria of fluency and flexibility, but they still find it hard to come up wiyh something of novelty. At their level, proposing and solving many problems with several different strategies are easier than those of with new ways or strategies. The same experience happens for students at level 1 where they are only able to fulfill the fluency aspect. The ideas used in proposing and solving problems at both levels (level 3 and level 1) are knowledge and questions that they have previously worked on or obtained both during the learning process in class and outside the classroom. When they propose a problem and cannot solve it because of a lack of information, they will provide the necessary information for the problem. However, if the problem is proven wrong, then they will return to the initial stage by compiling a new problem. This is in accordance with the theory of stage and componential process. Problem posing and solving begins with the preparation stage where the individual gathers information and defines the problem. Next is incubation, which involves time away from a problem, at least consciously. If the incubation is effective, a third stage occurs: enlightenment, or what Wallas calls illumination. At this point, a solution or idea suddenly presents itself (Runco & Chand, 1995; Wallas, 1926).

Students at level 2 are only able to fulfill novelty criteria. Students at this level have difficulty to provide more than one problem and strategy for solving it because they focus on composing and solving challenging problems that has never been solved before. Novelty is produc of a series of ideas and knowledge acquired while studying in class or studying independently, and then they are assembled into a new problem. This is in accordance with the cognitive theory that creative insights can result from associative processes. Mednick (1962) described how ideas are chained together, one after another, and how remote associates tend to be original. Meanwhile, level 0 cannot fulfill all aspects of creative thinking but they are able to solve problems given in class regardless. This suggests that students who are good at solving routine math problems or taking routine math tests may not be good at posing math problems (Van Harpen & Sriraman, 2013).

Determining the level of creative thinking in posing mathematical problems is measured through the fluency, flexibility and novelty of the given problem-posing and the correctness of solving the problem. From levels 0, 1, 2, 3 and 4, only students at levels 0 and 2 do not fulfill the fluency aspect. This is because they focuse too much on solving things that they consider the most difficult or challenging first. Meanwhile, the novelty aspect can only be fulfilled by students who are at levels 2 and 4 in problem-posing.

The results of the study also show that at the level of creative thinking levels 1, 2, 3, and 4, it is known that cognitive abilities play a role in producing various variations of problem-posing that students give. With careful analysis of student cognition during problem modification, problem-posing can provide useful evidence of student cognitive flexibility which helps in generating creative ideas. This is in line with research conducted by Akben (2020) that there is a positive relationship between metacognition, problem-posing skills, problem-solving, and creativity. However, student performance in problem-posing in this study was generally low in the semi-structural situation problem task. This suggests that students may need more experience and practice with problem-posing in order to have higher success in subsequent problem-posing.

Conclusion

This study aims to describe the ability of students' creative thinking levels in proposing and solving problems related to conditional probability. Determining the level of creative thinking in posing mathematical problems is measured through the fluency, flexibility and novelty of the given problem-posing and the correctness of solving the problem. From levels 0, 1, 2, 3 and 4, only students at levels 0 and 2 do not fulfill the fluency aspect. Meanwhile, the novelty aspect can only be fulfilled by students who are at levels 2 and 4 in problem-posing. In general, strategies used by students in each level to pose problems that meet the aspects of fluency, flexibility, and novelty are by modifying the questions that have been asked before. In addition, the problems raised by students in general are not too different in context. However, students who are at level 4 (very creative) are better at using posing and problem-solving strategies by fulfilling the three aspects of creative thinking which cannot be done at other levels (levels 0, 1, 2 and 3).

Limited number of subjects for each level of creative thinking participated during interviews is one of the limitations of this study. Involvement of a wider subject at each level of creative thinking may provide deeper and more comprehensive information about students' creative thinking processes in posing and solving given problems. In addition, this study only explored students' creative thinking skills at each level, while researchers did not provide a stimulus (e.g. assistance) related to the difficulties experienced by students at each level in posing and solving problems. Further research is expected to not only involves a wider range of subjects but also explores appropriate scaffolding for each level of creative thinking in order to improve students' creative thinking abilities..

Students need to be trained more often in terms of problem-posing in order to train and improve their creative thinking skills in conducting lectures. Therefore, by familiarizing students with creatively posing problems will encourage their ability to solve problems. Future research is expected to focus on improving students' creative thinking skills in problem-posing through the development or application of certain learning models or methods which are then tested for their effectiveness so that the results can later be applied to students in the learning process in class.

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