Game and creative problem solving in mathematics

Reni Untarti and Muhammad Ainun Najib
Universitas Muhammadiyah Purwokerto, Indonesia

E-mail: reniuntarti@ump.ac.id

Abstract. Although many people perceive that games harm student achievement, it is undeniable that games can have a positive effect on various student abilities, one of which is creative problem-solving in mathematics. The intensity of playing the game of course influences this influence. This study aims to describe creative problem-solving in mathematics in terms of the intensity of playing games. The research method used is descriptive with a qualitative approach. This research was conducted at SMP Negeri 2 Kutasari in the odd semester of the 2019/2020 school year. The research subjects were determined by purposive sampling technique and obtained by class IXA. The instruments used were creative problem-solving in mathematics tests and interview guides. Based on the results of the questionnaire, two students in each category were selected using purposive sampling technique for interviews. Data analysis techniques include: 1) data reduction, 2) data presentation; and 3) conclude. The results showed that students with low-intensity gameplay, either online or offline, are better at the mastery of creative problem-solving in Mathematics than students who play games with high intensity or students who do not play games.

1. Introduction
Mathematics has an essential role in modern human life, from school, workplace, business, to personal decision making [1]. Mathematics is also the basis of various fields of human life [2], so that mathematics is always present in human life [3]. Mathematics has a role in (1) training the way of thinking and reasoning in concluding; (2) developing creative activities that involve imagination, intuition and discovery by developing divergent, original thinking, curiosity, making predictions and guesses, and, experimenting; (3) develop problem-solving skills; and (4) developing the ability to convey information and communicate ideas [4].

Thinking is all mental activities in formulating, understanding, and solving problems or achieving specific goals [5]. By review, students can develop ideas and concepts in solving a problem. A situation which is a problem if someone realizes the existence of this situation, admits that the position requires action, but cannot immediately find a solution to the work [6]. Problems devided into three levels, namely simple problems, complicated problems, and complex problems [7]. Simple issues are problems that are still easy to face or solve. Simple problems are problems that can be solved by simple reasoning or logic [8]. Complicated problems are related problems, and the solutions are quite complicated. Complex problems are problems that have different and interrelated parts. Complex problems can be solved using creative mathematical problem-solving abilities.

Creative Problem Solving (CPS) is the ability to provide new solutions to a problem using knowledge, principles, concepts, and various thinking strategies. Mathematical CPS abilities prioritize new and relevant ideas in situations provide challenges, opportunities, that are related and have been planned in a way to answer or find answers [9]. Mathematical CPS is the ability to design a new and
unique way/idea to answer a problem that is being faced. Therefore, mathematical CPS must have creative aspects, not just problem-solving. This creative aspect is used to look for various ideas to choose the optimal and best solution. For students to master creative problem-solving abilities, they must understand essential concepts in mathematics, risk-taking, experience, and motivation [10].

The ability of mathematical CPS has three components, starting with divergent activities and ending with convergent movements [11]. The ability components contained in the mathematical CPS process are as follows [11-13]: the first component is (1) Understanding the problems which include: (a) constructing opportunities (mess-finding) which is in the form of identifying a situation (problem); (b) framing problems (problem finding), namely in the way of defining the problem correctly; The second component is (2) generating ideas which include (a) idea finding, which is in the form of writing ideas that can solve problems that have been encountered, the last component is (3) planning and action which includes (a) solution finding, namely in the form of deciding one idea that has been found to solve the problem; (b) acceptance finding, which is the ability to implement the chosen solution.

Nowadays, technology is what is needed in human life; technology has also spread in various aspects ranging from household, work, education, daily activities to entertainment. One technology that cannot be separated from human needs is a smartphone. The demand for smartphones has become a daily necessity, including school students because most educational institutions allow students to bring smartphones, which has the reason students can dig up information via the internet. However, in reality, most students use smartphones to play games. Apart from smartphones, students also use other technologies to play games, one of which is a computer where students can use a computer laboratory as a media to play games during breaks, not infrequently students also go to internet cafes after school time is over.

The intensity of playing games can affect the learning ability and intelligence of children either good or not. The intensity of playing games can have a positive or negative impact on students' cognitive [14]. One of the good effects of playing games is the increased ability to reason or logic. In the game, there are problems that you have to find a way out to reach a particular stage or goal. Therefore, it takes the ability to think and reason to be able to solve every problem in the game. His hobby is playing games can sharpen the brain to solve problems, so that his reasoning ability continues to develop[15]. However, children who play games excessively will harm cognitive development. If the game is played too, children cannot do the tasks given by the school, do not concentrate on the learning process, and even sleep in class. In addition, the learning motivation experienced decreases, such as laziness to learn so that it can affect cognitive development or intelligence of children [16].

Many studies have examined the effect of games on various student abilities, including student mathematics learning achievement, but not many have linked it to special skills in mathematics, one of which is Creative Problem Solving. Therefore, the aim of this study is to describe creative problem-solving in mathematics in terms of the intensity of playing games.

2. Method
The research method used is descriptive with a qualitative approach. Descriptive research is research that has the intention of understanding a phenomenon related to what is experienced by research subjects such as behaviour, perception, motivation, action and others holistically and by describing it in tenses and language in a specific context naturally and by various methods [17]. This research was conducted at SMP Negeri 2 Kutasari in the odd semester of the 2019/2020 school year. The research step was to choose class IX A as the research subject using purposive sampling technique with the consideration given by the counselling teacher that nearly 90% of the students like to play games. After that, the researchers made a research instrument in the form of a creative problem-solving ability test in mathematics, a questionnaire to collect data related to the intensity of playing games and interview guidelines. All students in class IX A were given the test and questionnaire. Based on the results of the questionnaire, two students in each category were selected using purposive sampling technique for interviews. The categories referred to are 1) students playing online games in the high category (21 hours per week); 2) students play online games with low intensity (less than 21 hours per week); 3) students play offline games with high category (21 hours per week); 2) students play offline
games with low intensity (less than 21 hours per week), and 5) students who do not play games. The consideration in selecting students to be interviewed is the results of creative problem-solving tests in mathematics and students' communication skills so that it is possible to obtain in-depth information related to creative problem-solving in mathematics. Data analysis techniques include: 1) data reduction, data from tests results and interviews are reduced according to research interests; 2) data presentation; data is presented and described. After that, technical triangulation was carried out, by checking the consistency between students' answers on tests and interviews; and 3) the final stage of data analysis is concluding.

3. Result and Discussion
In this study, Creative Problem Solving (CPS) in mathematics is defined into three stages, namely: understanding the problem; generating ideas; Planning and action. In understanding the problem students are asked to identify the problem by writing down the information that is known and asked in their own language, then presenting the information in the form of tables/graphs/pictures/diagrams/symbols / mathematical notations as appropriate. Besides, based on available information, students are asked to decide whether the problem presented can be solved or not. The second stage is generating ideas, where at this stage, students are asked to write down at least two concepts or two alternative methods or two formulas to solve the problem. The third stage is Planning and action. At this stage, students choose an idea/method/formula that is considered the most appropriate to solve the problem and its reasons. In addition, students are also asked to solve the problem based on the idea/method / formula chosen.

The following is an example of the answers of students playing games with high intensity.

![Picture 1. Answered Students with High Gameplay Intensity](image-url)

In picture 1 it can be concluded that these students did not write down alternative ideas/methods/formulas that can be used to solve problems, they directly solve problems using a method that was not written before. The process in question is to find each volume of the three shapes and then multiply it by the general cost. Based on picture 1, students experienced a student volume calculation error; the volume should have been 4,500. When calculating the volume of the pyramid, the students experienced a mistake in the multiplication part, $1/3 \times 75 \times 30 = 749.9$, what should be obtained is $1/3 \times 75 \times 30 = 750$. Also, students do not write down other ways that can be used to solve these problems. Therefore, students do not choose the method to be used, but instead, solve the problem directly without following the steps in the CPS. The results of the interview also showed that the students had difficulty solving these problems. This is because students experience weaknesses in the multiplication operation process. In addition, students have difficulties with thoroughness. The answers to student work with games and low intensity are in Figure 2 below.
Picture 2. Answered Students with Low Gameplay Intensity

Picture 2 shows that the students worked on the problem in two ways. In method 1, students answer by looking for the volume of each known shape. From these two ways, students can ultimately conclude which way is appropriate to solve the problem presented.

Students' answers to the type of no gameplay are presented in picture 3.

Picture 3. Answered Students with No Gameplay Intensity

Based on picture 3, it is known that students did not write down alternative ways / other ways to solve problems. Students immediately solve problems using only one method they know. From this answer, it is not visible that students' creativity in solving problems, because they only know one way, even though the answer is correct.

Table 1. Creative problem-solving in mathematics based on the intensity of playing games

| Jenis Game | Intensitas bermain game | Creative Problem Solving in Mathematics |
|------------|-------------------------|----------------------------------------|
| Online     | High                    | Be able to identify problems by existing information, but cannot redefine problems according to existing data. Besides, students cannot provide alternative ideas/methods/formulas to solve problems, so that students in solving problems only use the only way they have. |
| Offline    | High                    | Able to identify existing problems based on available information, but cannot define the problem. Able to write a method or strategy in solving problems, but only one system is written down so that only one way to solve the |
|            | Low                     | Able to understand the problems which include identifying problems and defining issues clearly. Students can go through the Generating Idea stage because they can provide ways or ideas to solve problems. Students are also able to master the planning and action stages, namely choosing between the two modes of solving problems and solving them. |
| Jenis Game | Intensitas bermain game | Creative Problem Solving in Mathematics |
|------------|-------------------------|----------------------------------------|
| Low        | Able to master the stage of understanding the problems, namely identifying problems and defining problems clearly according to the available information. Besides, students are also able to provide two ideas/methods/formulas to solve the issues and can choose and solve problems according to the ideas/methods/formulas they choose. |
| No play game | Be able to identify problems, but unable to redefine them. Students are not able to find other ideas/methods/formulas to solve problems, so they solve problems based on only one idea/method/formula that they know. |

Table 1. showed that students with good creative problem-solving abilities were students who played low-intensity games both online and offline.

From table 1, it can be seen that the CPS ability in the mathematics of students with low intensity of playing games both online and offline is better than other groups of students. These students master all indicators of creative mathematical problem-solving abilities, namely understanding the problems, Generating Ideas, and Planning and action. This is because when playing games, students are used to implementing strategies in their games. This strategy, for example, when students choose what hero to use to win the game and choose supporting items to make the hero better. Making decisions when selecting a hero also affects decisions in making decisions. Besides, the game also has a positive impact on solving problems. His hobby is playing games can sharpen the brain to solve problems so that his reasoning ability continues to develop [15]. The intensity of playing games that are not too much can have a positive impact on brain development. The intensity of playing games with a duration that is not too long will have a good effect on the intelligence or cognitive abilities of students [14].

The group of students with a high intensity of playing games, both online and offline, we’re unable to master CPS in mathematics better than the group of students with low game intensity. Students who play games with high intensity are students who feel addicted to games and are comfortable playing games for a long time. The impact, these students are lazy in doing assignments, lazy in learning, lazy to try, and lazy to choose a decision. This laziness will reduce the students’ cognitive abilities because his ability has never been honed. Children who play games with high intensity can harm cognitive development and students tend not to be able to do a given school assignment, do not concentrate and experience decreased learning motivation such as laziness to learn so that it has an impact on cognitive development or student intelligence [16].

The group of students who never played games were also unable to master CPS in mathematics better than students with low game intensity. This is because these students do not train their cognitive and creative abilities, while in the game, it can improve students’ cognitive, including in choosing strategies to solve these problems. But students with this category tend not to be able to express ways that can solve these problems. Students who do not play games have the reason that they have activities to fill their spare time, such as reading books and others.

4. Conclusion
Students with low-intensity gameplay, either online or offline, are better at the mastery of Creative Problem-Solving in Mathematics than students who play games with high intensity or students who do not play games. This is shown by his ability of Creative Problem Solving in Mathematics indicators. Students with low gameplay intensity can master all indicators, while other groups of students cannot.
Acknowledgement

The authors wish to thank the Mathematics Department, Faculty of Education and Teacher Training, Universitas Muhammadiyah Purwokerto and State Junior High School 2 Kutusari for giving the support in this research.

References

[1] Widana I W, Parwata I M Y, Parmithi N N, Jayantika I G A T, Sukendra K and Sumandy I W 2018 Higher order thinking skills assessment towards critical thinking on mathematics lesson International Journal of Social Sciences and Humanities 2 p 24-32

[2] National Research Council 2009 Mathematics learning in early childhood: Paths toward excellence and equity (National Academies Press)

[3] Untarti R and Kusuma A B 2020 Mathematics achievement vs parenting style International Journal of Advanced Science and Technology 29 p 24-32

[4] Depdiknas 2004 Kurikulum Mata Pelajaran Matematika SMP (Jakarta: Depdiknas)

[5] Johnson E B 2017 Contextual Teaching & Learning (Bandung : MLC)

[6] Sugiman and Kusumah Y S 2010 Dampak pendidikan matematika realistik indonesia terhadap peningkatan kemampuan pemecahan masalah siswa SMP Journal on mathematics education 1 p 41-51

[7] Steiner G 2009 The concept of open creativity : collaborative creative problem solving for innovation generation-a systems approach Journal of Business and Management 15 p 5-33

[8] Quesada J, Kintsch W and Gomez E 2005 Complex problem-solving: a field in search of a definition Theoretical Issues in Ergonomics Science 6 p 5-33

[9] Isrok’atun and Tiurlina 2014 Belajar matematika SD dengan berbantuan bahan ajar berbasis situation-based learning untuk meningkatkan kemampuan Creative Problem Solving (CPS) matematis siswa Jurnal Penelitian dan Pembekajaran Matematika, 7 p 1-13

[10] Erbas A K and Bas S 2015 The contribution of personality traits, motivation, academic risk-taking and metacognition to the creative ability in mathematics Creativity Research Journal 27 p 299-307

[11] Treffinger D J and Isaksen S G 2005 Creative problem solving: the history, development, and implications for gifted education and talent development Gifted Child Quarterly 49 p 342-353

[12] Osborn R 1963 Extending mathematics understanding (CE: Merrill Books)

[13] Kim H, Cho S and Ahn D 2004 Development of mathematical creative problem solving ability test for identification of the gifted in math Gifted Education International 18 p 164-174

[14] Manggena T F, Putra K P and Sanubari T P E 2017 Pengaruh intensitas bermain Game terhadap tingkat kognitif (kecerdasan logika-matematika) usia 8-9 tahun Satya Widya 33 p 146-15

[15] Afari E, Aldridge J M, Fraser B J and Khine M S 2013 Students’ perceptions of the learning environment and attitudes in game-based mathematics classrooms Learning Environments Research 16 p 131-150

[16] Suziedelyte A 2012 Can video game affect children’s cognitive and non-cognitive skills Australian School of Business Building 4 p 1-34

[17] Moleong L J 2013 Metodologi Penelitian Kualitatif (Bandung : PT Remaja Rosdakarya)