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How do working memory capacity and math anxiety affect the creative reasoning abilities of prospective mathematics teachers?

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Abstract: Creative reasoning involves generating new ideas and finding unusual solutions to a problem using an innovative approach. Creative reasoning allows individuals to develop diverse problem-solving strategies. However, mathematics anxiety, as an affective domain in mathematics learning, can inhibit cognitive performance in problem-solving. This research examines the impact of working memory capacity and mathematics anxiety and describes the creative reasoning process in solving mathematical problems. The sample of this study consisted of 62 prospective mathematics teacher students. This research employed a mixed-methods sequential explanatory design. The test scores were analyzed using multiple linear regression tests with an alpha level of .05. Meanwhile, qualitative data were collected for the second stage based on observations, geometric problem-solving tasks, and interviews. Qualitative data were analyzed in three phases: data presentation, reduction, and conclusion drawing. The results show that working memory capacity and mathematics anxiety influence the creative reasoning of prospective mathematics teachers in solving mathematical problems. Prospective mathematics teachers with high working memory capacity are flexible and fluent in their thinking, encouraging them to use novel ideas to solve problems. In addition, they can put forth logical arguments grounded in correct basic mathematical concepts. However, high mathematical anxiety may interfere with their thinking ability and inhibit their performance. When faced with a complex mathematical problem, they make incorrect answers. On the other hand, subjects with low working memory capacity are less flexible in thinking, which prevents them from using novel ideas when solving problems.

Keywords: *Creative reasoning, Mathematics anxiety, Problem solving, Working memory capacity.*

1. Introduction

Creative thinking is important because, according to UNESCO's IBE [1] We live in a world that requires creative thinking to solve problems that develop quickly and are complex. Report of European Parliament and Council: At the European level, creativity is recognised as a transversal aspect of all the key competencies of lifelong learning [2]. For growing 'creative ways of teaching and learning' and 'creative thinking' have emerged in recent policy documents. In another study, creativity appeared much more often in the curriculum of arts-related subjects than in other subjects, with a higher ratio of creativity occurrences in the UK national curriculum than in the European Union. Council of Europe report that DGI, a person's brain processes images at an incredible speed compared to text. As a result, our critical reasoning skills tend to be less effectively used with what we see. Thus, creativity is needed.

The PISA (Program for International Student Assessment) study results show that students' mathematics performance in Indonesia still requires improvement. The mathematics performance of Indonesian students received a score of 366 [3] while the average PISA score globally was 489. This means that the PISA score of Indonesian students is still below average. This shows that

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Indonesian students' understanding of mathematical concepts and problem-solving abilities still needs to be improved. Mathematical problem-solving is an important teaching medium because problem-solving teaches many mathematical concepts and operations well. Mathematical problem-solving is a central part of mathematics learning, so it is necessary to develop problem-solving skills for prospective mathematics teachers as a provision when teaching mathematics to their students. When entering teacher education institutions, prospective mathematics teachers hold several beliefs about mathematics, teaching and learning, the goals of teaching, and their ability to teach mathematics [4].

Mathematics is fundamentally a cognitive domain; it is also important to examine the creative reasoning ability of future mathematics teachers in the affective domain, as factors in this domain also affect students' mathematics learning. The affective domain encompasses students' moods and feelings (e.g., anxiety, confidence, and satisfaction upon solving mathematical tasks), the atmosphere in which the learning process takes place, and the individual aspect of the students themselves [5]. Anxiety, in particular, causes students to have negative perceptions of mathematics, which causes them to be inclined to feel that they cannot succeed in mathematics.

The cognitive domain is related to problem-solving, a set of skills essential for everyday life as well as other areas, including science and technology, and the attention to individual differences and the provocations during the challenging and alternative phase stimulates the emergence of new ideas that contribute to the improvement of individuals' mathematical creativity [6]. Problem-solving is doing non-routine tasks where the solver does not know the previously learned scheme designed to solve it [7]. In mathematics, it is also important to practice problem-solving and higher-order skills that students often struggle with Öztürk, et al. [8]. Solving problems requires several cognitive skills, including creative reasoning [9]. Research findings suggest that creative reasoning is pivotal to developing problem-solving skills, especially in mathematics [10]. This skill has been extensively studied, particularly in innovative thinking, mental flexibility, and other psychological aspects. As with problem-solving, creative reasoning has become a significant focus on cognitive psychology and education.

Creative reasoning in mathematical problem-solving involves thinking creatively, flexibly, and with openness to different approaches. It also involves looking at problems from different perspectives, searching for alternative solutions, using imagination, and thinking associatively. Research has put forward aspects of problem-solving, such as the activities and competencies required for constructive problem-solving, as central issues [11]. Creative reasoning in problem-solving is characterised by the accompaniment of reasonable arguments and a mathematical basis [12]. Creative reasoning in mathematics can help future mathematics teachers find unique solutions or approach problems in new ways.

Although creative reasoning concerning mathematical problem-solving has grown into an increasingly popular research topic, there remains a gap between research and the current state of learning. Prospective mathematics teachers need to identify this gap in preparation for future teaching activities at school, implementing tasks that encourage reasoning and problem-solving as an effective mathematics teaching practice [13]. Analysis of this gap reveals that creative reasoning is often not directly integrated into current mathematics education curricula, highlighting discrepancies between research findings and daily learning practices in universities and schools. Educators of prospective mathematics teachers should consider encouraging these prospective mathematics teachers to enable students to engage in volition-enabling prompts through problem-solving, which is a central component of mathematics teaching [14]. In addition, it is important for policymakers in teacher training institutions, as well as practitioners in education, to work together to integrate research results on creative reasoning into learning practices, with particular attention to the gap addressed earlier, and create learning environments that support the development of creative reasoning effectively among students.

Existing research on working memory capacity and mathematics anxiety in prospective teachers primarily focused on the influence of these factors on teaching effectiveness rather than cognitive performance. Many research studies on mathematics anxiety have been carried out in mathematics education, and this theme influences mathematics learning [15]. Working memory capacity significantly impacts various cognitive processes, including mathematical problem-solving [16]. In this case, working memory capacity stores information that can be recalled when faced with problem-solving. Working memory capacity is critical in supporting cognitive abilities in understanding, reasoning, and solving problems. Therefore, this study aimed to discover how working memory capacity is a cognitive factor essential for acquiring basic learning competencies [17, 18]. Affects creative reasoning, particularly in prospective mathematics teachers. The results of this study are expected to be helpful in identifying suitable methods for improving the performance of prospective mathematics teachers' reasoning skills. As mathematics teachers are expected to be able to contribute to the development of students' critical and creative thinking skills, which are necessary for solving mathematical problems, creative reasoning may provide prospective mathematics teachers with new ways to address students' difficulties in learning mathematics, including those with anxiety. In addition, the results of this study are likely to provide new insights into how future mathematics teachers can improve their ability to solve mathematical problems creatively and effectively

2. Research Methodology

2.1. Design

This research employed a mixed-methods sequential explanatory design. Quantitative methods were used to determine the influence of working memory capacity and mathematics anxiety on the creative reasoning of prospective mathematics teachers. A multiple regression test was carried out twice, with working memory capacity test scores and math anxiety test scores serving as independent variables. A test of mathematics problem-solving, serving as a dependent variable, was developed with creative reasoning indicators to measure the creative reasoning performance of prospective mathematics teachers in problem-solving. In addition, to see how the creative reasoning of prospective mathematics teachers varied with different levels of working memory capacity and mathematics anxiety in problem-solving, qualitative research methods were used. The qualitative research methods involved 10 out of 62 subjects, five with low working memory capacity and five with high working memory capacity. All of these subjects had high levels of mathematics anxiety. They were given a geometry problem to solve.

2.2. Research Subject

In this research, a sample was selected by cluster random sampling. The sample consisted of two clusters, one comprising second-year students and the other comprising third-year students. From each cluster, one class was randomly selected. A total of 62 prospective mathematics teachers aged 19–22 were selected as subjects. The sample was given the OSPAN Task as a working memory capacity and mathematics anxiety test instrument.

2.3. Procedures and Data Collection

In this study, several data collection instruments were used. The Operation Span Task (OSPAN Task) measured working memory capacity. It assessed a subject's ability to focus on two tasks at once. The OSPAN Task was adapted from Turner and Engle [19] and can be seen in Juniati and Budayasa [20]. The sample was given a mathematical operation task and asked to remember numbers simultaneously. The OSPAN Task results would serve as the basis for grouping the sample into two categories: high working memory capacity and low working memory capacity. Subjects with OSPAN Task scores above 60% were included in the high working memory capacity category, and those with OSPAN Task scores below 60% were included in the low working memory capacity category. Meanwhile, mathematics anxiety was measured using a mathematics anxiety instrument developed by Juniati and Budayasa [20]. The instrument assesses three components: anxiety about learning mathematics (four items: item 1 to item 4), anxiety about taking mathematics courses (five items: item 5 to item 9), and anxiety about taking mathematics exams (six items: item 10 to item 15). Responses were rated on a four-point Likert scale: "never" (score 1), "rarely" (score 2), "often" (score 3), and "always" (score 4). Subjects with mathematics anxiety scores of 1–30 were included in the low mathematics anxiety category, while those with mathematics anxiety scores greater than 30 were included in the high mathematics anxiety category. Data on creative reasoning in problem-solving were collected using a problem-solving test instrument. This instrument contains mathematics questions on plane geometry.

Working memory capacity test scores, mathematics anxiety test scores as independent variables, and creative reasoning test scores as dependent variables were analysed using multiple linear regression tests. The OSPAN Task was administered to measure working memory capacity. In this test, each number that needed memorisation was displayed for four seconds, along with the operation to be performed. At the end of the process, each subject was given 10 seconds to write down all the numbers they had to recall correctly according to the instructions.

The working memory capacity score was obtained by summing the numbers correctly recalled in the correct order. The percentage of correct answers for operations must be at least 80%. The working memory capacity score fell in the range of 0–100. The quartile separation technique of the OSPAN Task was applied to analyse the scores [21]. In the mathematics anxiety test, each subject was given 15 questions. The score fell within the range of 0–60. It was calculated by dividing the total score by the maximum score and multiplying the result by 100. Meanwhile, the problem-solving test, which measured creative reasoning, was administered by giving each subject two problems to work on. An assessment rubric was provided based on the level of creativity for each question. The creative reasoning score fell within the range of 0–80. It was calculated by dividing the total score obtained by the maximum score and multiplying it by 100.

The data obtained were validated using the triangulation method by re-administering the problem-solving test at a different time to assess the consistency of the answers given by the subjects. Working memory capacity data were grouped into high working memory capacity and low working memory capacity, and mathematics anxiety data were grouped into high mathematics capacity and low mathematics anxiety. In this study, only subjects with high mathematics anxiety were selected for further assessment, regardless of whether their working memory capacity was high or low. Qualitative data were analysed in three stages: data presentation, reduction, and conclusion drawing.

2.4. Results

Present the findings related to the first research question or hypothesis. Clearly state the results and provide any relevant statistical or qualitative data. Quantitative data on the influence of working memory capacity and mathematics anxiety on the creative reasoning performance of prospective mathematics teachers were analysed using a multiple linear regression test. The results are presented in Table 1.

Table 1.
Summary of Multiple Linear Regression Test Results.

Multiple R	R-Square	Adjusted R-Squared	Standard Error	Observations
0.4566	0.2085	0.1816	26.151	62

Based on Table 1, the multiple R-value was .456. This value indicated the relationship between the independent variables (working memory capacity and mathematics anxiety) and the dependent (creative reasoning) variables. Then, an R-squared value of .2085 indicates that the independent variables explain around 20.85% of the variance in the dependent variable. This shows that the influence of working memory capacity and mathematics anxiety on the creative reasoning performance of prospective mathematics teachers in solving mathematical problems was low. An adjusted R-squared value of .1816 indicates that, after considering the number of predictors, approximately 18.16% of the variance in the dependent variable could be explained by the independent variables, highlighting that the independent variables in this regression model might not be strong predictors. This also shows that around 18% of the variance in prospective mathematics teachers' creative reasoning in problem-solving was influenced by working memory capacity and mathematics anxiety, while other factors influenced the rest.

Table 2.
ANOVA Results on Creative Reasoning, Working Memory Capacity, and Mathematics Anxiety.

	df	SS	MS	F	Significance F
Regression	2	10629	5314.501	7.77119885	0.0010098
Residual	59	40348.42	683.8715		
Total	61	50977.42			

Table 2 shows that the multiple linear regression had 59 degrees of freedom (df) associated with residuals. The regression sum of squares (SS) was 10629, the residual SS was 40348.42, and the total SS was 50977.42. The mean square (MS) was the result of dividing SS by the df of each component. This analysis obtained an F-value of 7.7711 and a significance value of .0010098. The F-value and significance value were used to test the null hypothesis, ensuring no relationship existed between the independent variables and the dependent variable in the regression model. Because the significance value was smaller than the alpha level (.05), the null hypothesis was rejected, leading to a conclusion that at least one of the independent variables in the regression model significantly influenced the dependent variable. This means that working memory capacity and mathematics anxiety significantly influenced the creative reasoning of prospective mathematics teachers in solving mathematical problems. The observation that working memory capacity appears to affect mathematics performance positively. Working memory capacity positively affected math performance (basic and advanced math skills, problem-solving skills). At the same time, mathematics anxiety negatively affected advanced math and problem-solving skills [22]. Cognitive independence affects basic math skills but does not affect advanced math skills. Working memory capacity positively affected math performance (basic and advanced math skills, problem-solving skills). At the same time, mathematics anxiety negatively affected advanced math and problem-solving skills [23].

Table 3.
Coefficients of Creative Reasoning, Working Memory Capacity, and Mathematics Anxiety.

	Coefficients	Std. Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-3.7038	25.3595	-0.1461	0.8844	-54.4480	47.0405
WMC (X1)	0.6044	0.1622	3.7271	0.0004	0.27992	0.9289
Anxiety (X2)	0.380	0.3374	1.1264	0.2646	-0.2951	1.0551

Based on Table 3. Intercept Value: -3.7038. This is the predicted value of the dependent variable when all independent variables (X1 and X2) are equal to zero. X1=.6044. This means that every one-unit increase in X1 is expected to increase the value of the dependent variable by .6044, assuming X2 remains constant. X2 value: .380. This means that each one-unit increase in X2 is expected to increase the value of the dependent variable by .380, assuming X1 remains constant. Standard Error: This is a measure of uncertainty in the coefficient estimates. Intercept Value: 25.3595. This figure shows that there is high uncertainty in the intercept estimate. X1 value: .1622, a smaller standard error indicates that the estimated coefficient X1 is more stable; the value of X2: .3374, and a larger standard error of X1 indicates greater uncertainty in the estimated coefficient X2.

This is the t statistic used to test the significance of coefficients and calculated by dividing the coefficient by the standard error Intercept value: -0.1461. This value is close to zero, indicating that the intercept is not statistically significant. X1=3.7271, this shows that the coefficient X1 is statistically significant. X2=1.1264. This value is also close to zero, indicating that X2 is not statistically significant. P-value: This is the probability that the coefficient under test equals zero. Intercepts: .8844. This indicates that the intercept is not significant at the .05 level. X1=.0004 shows that X1 is very significant ($p < .05$). X2=.2646, which shows that X2 is not statistically significant. These are the 95% confidence intervals for the coefficients. Intercept, the confidence interval (-54.4481, 47.0405) shows that cannot reject the hypothesis that the actual intercept can vary widely, including a large negative probability. The confidence interval X1=(.2799, .9289) shows that we are very confident that X1 has a significant positive influence on the dependent variable, and the confidence interval X2 = (-0.2951, 1.0551) indicates that we cannot conclude that X2 has a significant effect. Someone who has low math anxiety is more successful in solving geometry problems compared to someone with higher math anxiety, and someone with excessive levels of mathematics anxiety can hinder their performance in solving geometric problems [24].

The regression test results show that X1 and X2 are independent variables that influence the dependent variable because the p-value is below .05. This study is consistent with previous research on the relationship of working memory to mathematics learning and achievement in children [25]. In the regression model Y = -3.70379+.604415X1+0.38002X2, if X1= 0, X2=0, then Y = -3.70379, and if X had a positive value of 1, then Y = -3.70379+ 0.604415+ .38002. The greater the value of X, the greater the value of Y. In other words, the higher a person's working memory capacity, the higher their level of reasoning.

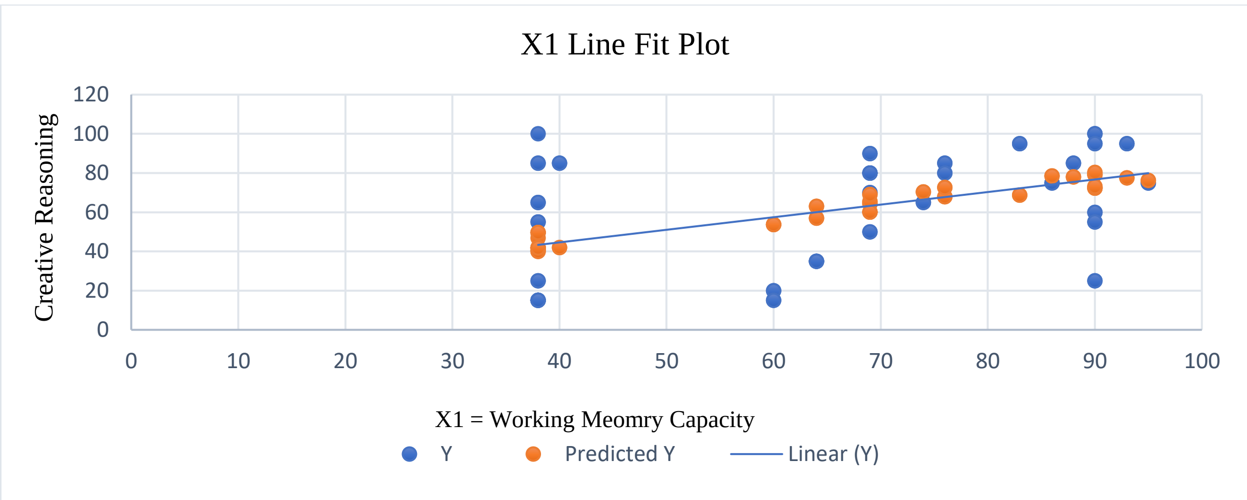

Figure 1.
Creative Reasoning in Problem-Solving Line Fit Plot X1.

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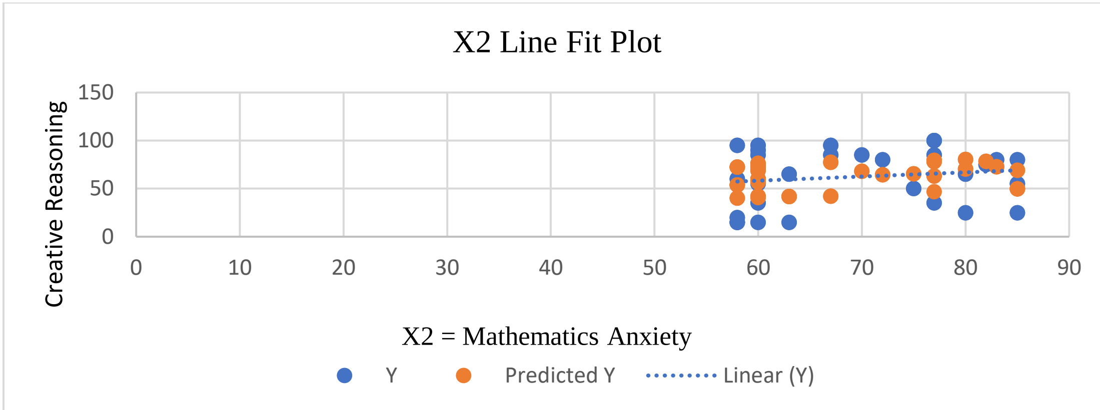

Figure 2.
Creative Reasoning in Problem-Solving Line Fit Plot X2.

Based on Figures 1 and 2, working memory capacity and mathematics anxiety influenced the creative reasoning of prospective mathematics teachers when solving mathematical problems, and other factors might also influence this.

2.5. High-Working-Memory-Capacity Subject with High Anxiety

Subjects with high working memory capacity and mathematics anxiety could solve a given problem by offering several solutions and logical mathematical arguments. One of these subjects was Indah (pseudonym). Indah made house plans according to the specified requirements. Her first step was to sketch a piece of land with an area of 168 m^2 in a non-rectangle shape. The resulting sketch took the shape of a trapezoid.

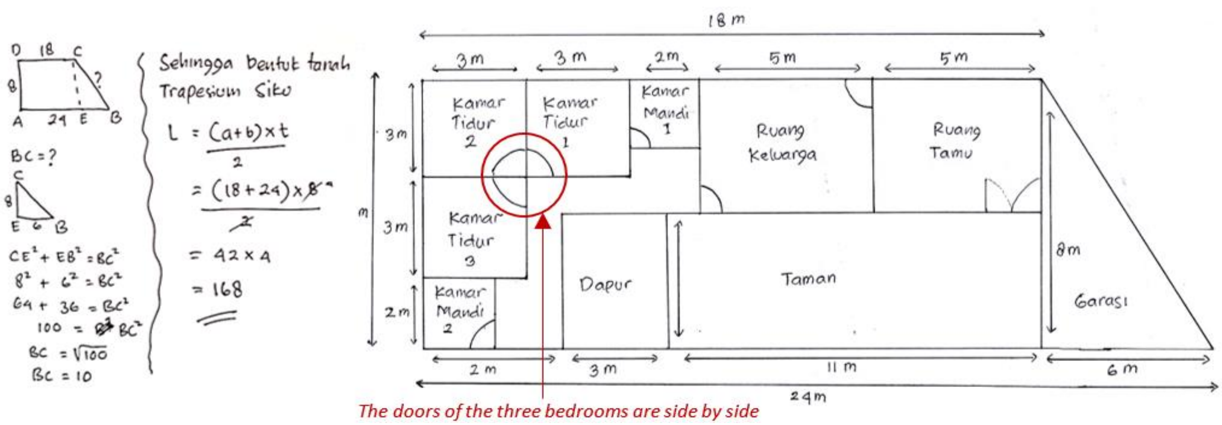

Figure 3.
A Sketch by A High-Working-Memory-Capacity, High-Mathematics-Anxiety Subject.

Figure 1 presents Indah's sketch of a piece of land as a trapezoid, with an area of 168 m2. The height of the trapezoid was eight meters, the base was 24 meters long, the top was 18 meters long, and the hypotenuse was 10 meters long. Indah divided the trapezoid ABCD into two parts: a rectangle AECD, with AD = 8 and AE = 18 meters, and a right triangle CEB, with EB = AB - AE = 24 – 18 = 6 and AC = 8. Using the Pythagorean theorem formula, the hypotenuse BC was 10.

An interview revealed fluency and flexibility in Indah's creative reasoning. The novelty of the idea could be seen from how she sketched the plan according to the requirements laid down in the question. She provided logical arguments, which made her reasoning make sense. The mathematical formulas that she used to support her arguments were appropriate. However, she appeared to experience anxiety, which interfered with her cognition. Loss of focus caused her to fail to solve the question successfully, although she understood the meaning of the question. Upon a closer look, it became clear that she sketched her plan with three bedrooms clustered together. Even though the size of the bedrooms met the requirements (with minimum dimensions of 3x3 meters), the placement of the bedrooms in the corner of the house, adjacent to each other, left one bedroom with a door placement that did not make sense, which she realised when asked for clarification.

This result shows that the creative reasoning process of a high-memory-capacity subject could be disrupted by high mathematics anxiety. The subject was able to answer systematically, accompanied by logical arguments, but she was poor at dealing with her anxiety in the presence of stress from the limited time for completing the question, preventing her from answering carefully.

2.6. Low-Working-Memory-Capacity Subject with High Anxiety

Faro (pseudonym), a participant with low working memory capacity and high math anxiety, solved the same problem by directly sketching an angled trapezoid with an area of 168 m2. Mathematically, the sketch created met the requirements.

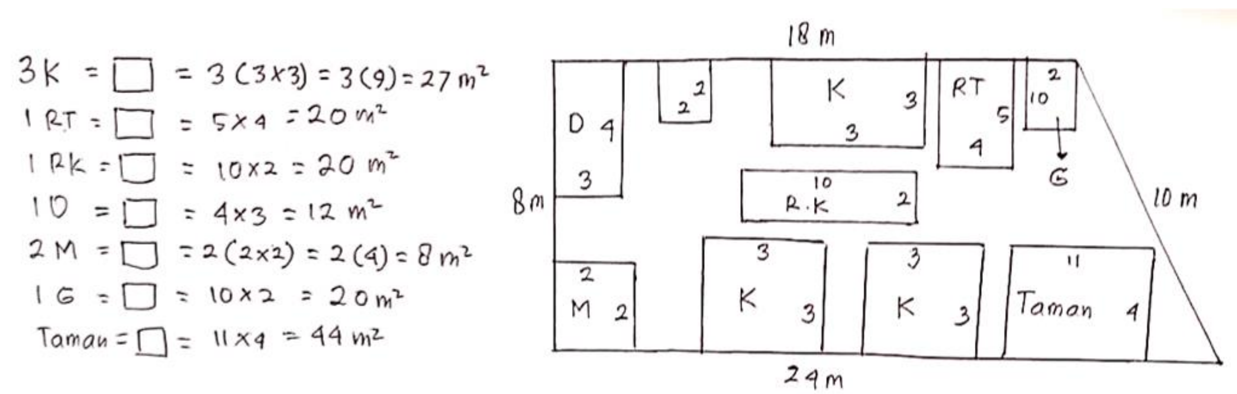

Figure 4.
A Sketch by a Low-Working-Memory-Capacity, High-Mathematics-Anxiety Subject.

After making a sketch, Faro calculated the floor plan area according to the requirements, consisting of three bedrooms, each measuring 3 x 3 meters at minimum (total area = 27 m2), one living room measuring 4 x 5 meters (total area = 20 m2), one family room measuring 10 x 2 meters (total area = 20 m2, which did not exceed the maximum area requirement of 25 m2), one kitchen measuring 4 x 3 meters (total area = 12 m2), two bathrooms each measuring 2 x 2 meters (total area = 8 m2), one garage measuring 10 x 2 meters (total area = 20 m2), and one garden measuring 11x4 meters (total area = 44 m2).

Faro assumed that by using the minimum size and keeping the size below the limits set in the question, the room plan would fit within the available land area. Upon calculation, she found out that the total area covered by all rooms sketched in the plan was 151 m2, with the non-rectangular piece of land covering an area of 16 m2. This means that all rooms fit within the land area. Her creative reasoning was evident in her making a solution by following the requirements. She also provided logical arguments for the sizes of the rooms being created. For example, it was determined that the size of the family room should not exceed a maximum area of 25 m2. Thus, she designed the family room to be 10 long and 2 meters wide (total area =20). Mathematically, she gave arguments that made sense, as the size of the family room did not exceed the 25 m2 limit.

Figure 4 shows the result of Faro's work. After calculating the area of each room, she incorporated the rooms into the sketched plan. However, it was not done systematically. There was unused space that appeared large even though it should only cover an area of 17 m2 (168 m2 – 151 m2). Faro did not use much creativity in arranging the rooms in the sketch. However, she provided logical arguments, ensuring that the total area of the rooms did not exceed the land area. The unused space looked large because she did not sketch the plan to the correct scale. She focused only on finishing the task and did not consider whether the room layout made sense. On the other hand, Faro has high mathematical anxiety, which hurts his creative reasoning abilities. Faro felt less confident and was reluctant to provide arguments for the answers he had made.

3. Discussion

Thinking and reasoning are indispensable in the mathematical problem-solving process. In the reasoning process, the cognitive system plays a huge role. It performs its function in finding relevant information to solve the problems. This information is stored in memory and is later recalled when needed. The more information stored in memory, the easier it is to retrieve appropriate information for problem-solving. Memory has a different capacity for every person [26]. This difference impacts cognitive performance when reusing the information needed to solve problems.

A person's cognitive performance can be disrupted by anxiety. Anxiety makes it difficult for a person to concentrate. It also inhibits cognitive activity. Something that is usually easy for someone can become difficult because of excessive anxiety. Math anxiety causes decreased academic performance on math tasks, preventing students from achieving good results in the learning process [27]. This includes mathematics anxiety, a type of anxiety associated with mathematics. Mathematics anxiety negatively influences arithmetic skills and mathematics performance [28]. As a result, the problem-solving process is less flexible and systematic.

Subjects with high working memory capacity tended to exhibit flexibility and fluency in their creative reasoning process, as shown by their proposed novel ideas. They met the requirements for designing the rooms, although the size of each room varied. This was the logical argumentation underlying their selection and application of new ideas in solving problems. They also developed a systematic, structured room layout. The use of the Pythagorean theorem formula in designing the non-rectangle land section showed that they used the proper mathematical basis to support their creative reasoning, and the variance with which they positioned the rooms without compromising the specified conditions showed thinking fluency and flexibility that supported their creative reasoning.

Subjects with high working memory capacity had a lot of information and systematically solved problems with novel ideas and reasonable arguments. Working memory capacity is critical in supporting cognitive performance in understanding, reasoning, and solving problems [28]. However, high mathematics anxiety from a stressful situation and limited working time disrupts concentration, resulting in less accurate answers. The mathematics anxiety level of prospective math teachers was relatively high and had a significant adverse effect on mathematics performance [22].

On the other hand, subjects with low working memory capacity had little information for solving problems, necessitating them to go through a pre-calculation phase to obtain necessary information. As a result, they provided solution ideas with less novelty. Low working memory capacity made it difficult for them to retain important information when working on the math problem. To be precise, they did not appropriately apply the concept of scale in solving the problem. Nevertheless, they could provide reasonable arguments to back their answers. These subjects had a high level of anxiety, which interfered with their cognitive performance. They experienced pressure from limited processing time and fear and doubt regarding the correctness of their answers, which hindered them from systematically making accurate solutions. Low working

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memory capacity hindered subjects' progression along this process, making it hard to track their sequence of actions or see relationships between steps. It made it difficult for them to maintain and use short-term information correctly, leading to confusion or errors at later stages. Furthermore, low-working-capacity subjects had difficulty maintaining focus while performing several tasks or transferring information from one stage to another. Coordination between various aspects, such as number manipulation, arithmetic operations, application of specific concepts, and choice of problem-solving strategies, was critical. In addition, these subjects were not fluent in manipulating answers with logical arguments.

Anxiety emerged when the subjects sketched the rooms. The confusion they experienced showed that anxiety was beginning to interfere with and inhibit their cognitive performance. They were unable to create a systematic room layout. Mathematics anxiety interfered with their concentration and cognitive performance, thereby impacting their problem-solving results. This is in line with García-Santillán, et al. [28] finding that mathematics anxiety has a negative influence on arithmetic skills and mathematics performance.

Subjects with low working memory capacity demonstrated less flexible and fluent thinking in their creative reasoning process. They still needed to do initial calculations to confirm their answers. Only one room, the family room, had a variation in size, where one participant designed it to be 10 meters long and two meters wide, giving it an area of 20 m2. This size remained below the maximum area requirement of 25 m2. No variation was applied to the rest of the rooms, indicating that the subjects were not too flexible and fluent in finding new ideas. However, they could provide reasonable arguments based on correct basic mathematical concepts. This happened because subjects with low working memory capacity lacked sufficient information to solve problems. Subjects with low working memory capacity use a novel strategy, providing predictive and verification reasons for selecting strategies and convincing reasons by the intrinsic mathematical properties [29]. High mathematics anxiety made it even harder for the subjects to sketch their plans systematically and organised. Mathematics anxiety can hurt mathematical problem-solving. Not only does it cause cognitive deficits, but it also evokes a physiological reaction [30].

Subjects with low working memory capacity already understood the question, as shown by the answers they obtained by calculating the area of each room. However, they found space when incorporating those rooms in a sketched plan. These participants were identified as having high mathematics anxiety. From their work, it appeared that their anxiety had interfered with their concentration and cognitive processes in solving the problem, causing them to make inappropriate answers. This shows that a person's anxiety can hinder thinking. These findings are consistent with the research results [3] which showed that individuals with high mathematical anxiety are less systematic and logical in providing arguments, even though they provide proof to back their proposed ideas. They formulate assumptions based on inaccurate arguments. Working memory is limited, limiting a person's ability to process information. Working memory capacity is important for many cognitive processes, including understanding, reasoning, and problem-solving. It appears to positively impact mathematics performance, including basic and advanced mathematics skills and problem-solving skills, while mathematics anxiety has a negative effect.

4. Conclusion and Suggestions

Working memory capacity and mathematics anxiety influence the creative reasoning of prospective mathematics teachers in solving mathematical problems. Prospective mathematics teachers with high working memory capacity are flexible and fluent in their thinking, encouraging them to use novel ideas to solve problems. In addition, they can put forth logical arguments grounded in correct basic mathematical concepts. However, high mathematical anxiety may interfere with their thinking ability and inhibit their performance. When faced with a complex mathematical problem, they make incorrect answers. On the other hand, subjects with low working memory capacity are less flexible in thinking, which prevents them from using novel ideas when solving problems. They still use general reasoning based on previously known information. High mathematics anxiety hinders their cognitive performance in solving problems even further, resulting in inaccurate answers.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1] OECD, *PISA 2022 results (Volume II): Learning during – and from – disruption*. France: OECD Publishing, 2023.

[2] A. Hool *et al.*, "A review of methods and data to determine raw material criticality," *Resources, Conservation and Recycling*, vol. 155, p. 104617, 2020. https://doi.org/10.1016/j.resconrec.2019.104617

[3] A. R. Strohmaier, A. Schiepe-Tiska, and K. M. Reiss, "A comparison of self-reports and electrodermal activity as indicators of mathematics state anxiety. An application of the control-value theory," *Frontline Learning Research*, vol. 8, no. 1, pp. 16-32, 2020. https://doi.org/10.14786/FLR.V8I1.427

[4] D. L. Ball, J. Ferrini-Mundy, J. Kilpatrick, R. J. Milgram, W. Schmid, and R. Schaar, "Reaching for common ground in K-12 mathematics education," *Notices of the AMS*, vol. 52, no. 9, pp. 1055-1058, 2005. https://doi.org/10.1090/noti1510

[5] R. Hembree, "The nature, effects, and relief of mathematics anxiety," *Journal for Research in Mathematics Education*, vol. 21, no. 1, pp. 33-46, 1990. https://doi.org/10.5951/jresematheduc.21.1.0033

[6] L. J. Shodiq, D. Juniati, and Susanah, "Influence of personal background on lateral thinking skill of prospective mathematics teachers," in *AIP Conference Proceedings, AIP Publishing LLC*, 2023, vol. 2886, no. 1, p. 020011.

[7] B. Hasan and D. Juniati, "The influence of working memory capacity on the creative reasoning of prospective mathematics teacher," in *Proceeding of the Global Conference on Innovations in Education*, 2024.

[8] M. Öztürk, Y. Akkan, and A. Kaplan, "Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey," *International Journal of Mathematical Education in Science and Technology*, vol. 51, no. 7, pp. 1042-1058, 2020. https://doi.org/10.1080/0020739X.2019.1648893

[9] N. Althuizen and B. Wierenga, "Supporting creative problem solving with a case-based reasoning system," *Journal of Management Information Systems*, vol. 31, no. 1, pp. 309-340, 2014. https://doi.org/10.2753/MIS0742-1222310112

[10] A. H. Schoenfeld, "On paradigms and methods: What do you do when the ones you know don't do what you want them to? Issues in the analysis of data in the form of videotapes," *The Journal of the Learning Sciences*, vol. 2, no. 2, pp. 179-214, 1992. https://doi.org/10.1207/s15327809jls0202_3

[11] J. Lithner, "A research framework for creative and imitative reasoning," *Educational Studies in Mathematics*, vol. 67, no. 3, pp. 255-276, 2008. https://doi.org/10.1007/s10649-007-9104-2

[12] O. Chapman, "Constructing pedagogical knowledge of problem solving: Preservice mathematics teachers," *International Group for the Psychology of Mathematics Education*, vol. 2, pp. 225-232, 2005.

[13] M. D. C. Lerik, T. D. Hastjarjo, and R. Dharmastiti, "Situation awareness viewed from sense of direction and choice of navigation direction," in *Proceedings of the ICPsy 2019*, 2020, pp. 352–362.

[14] Y. Fu and O. Kartal, "Developing preservice teachers ' self -efficacy and growth mindset for teaching mathematics : Practices from a mathematics methods course," *Mathematics Teacher Education and Development*, vol. 25, no. 2, pp. 1–19, 2023. https://doi.org/10.5220/0009820503520362

[15] J. Russo, M. Minas, T. Hewish, and J. McCosh, "Using prompts to empower learners: Exploring primary students' attitudes towards enabling prompts when learning mathematics through problem solving," *Mathematics Teacher Education and Development*, vol. 22, no. 1, pp. 48-67, 2020. https://doi.org/10.1007/s11858-020-01136-x

[16] J. Wiley and A. F. Jarosz, "Working memory capacity, attentional focus, and problem solving," *Current Directions in Psychological Science*, vol. 21, no. 4, pp. 258-262, 2012. https://doi.org/10.1177/0963721412447622

[17] W. Y. Ei and C. Z. Oo, "Effects of a working memory training program on secondary school students' mathematics achievement," *Mathematics Teaching Research Journal*, vol. 15, no. 5, pp. 177-192, 2023.

[18] L. Farkacová, M. Králová, and E. Zelendová, "Math anxiety, skills, and work-related competencies: A study on Czech university students," *Mathematics Teaching Research Journal*, vol. 15, no. 6, pp. 20-38, 2024. https://doi.org/10.5220/0009820503520362

[19] M. L. Turner and R. W. Engle, "Is working memory capacity task dependent?," *Journal of Memory and Language*, vol. 28, no. 2, pp. 127-154, 1989. https://doi.org/10.1016/0749-596X(89)90040-5

[20] D. Juniati and I. K. Budayasa, "Working memory capacity and mathematics anxiety of mathematics undergraduate students and its effect on mathematics achievement," *Journal for the Education of Gifted Young Scientists*, vol. 8, no. 1, pp. 271-290, 2020. https://doi.org/10.17478/jegys.653518

[21] M. J. Kane, A. R. Conway, T. K. Miura, and G. J. Colflesh, "Working memory, attention control, and the N-back task: a question of construct validity," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, vol. 33, no. 3, pp. 615–622, 2007. https://doi.org/10.1037/0278-7393.33.3.615

[22] D. Juniati and I. Budayasa, "The mathematics anxiety: Do prospective math teachers also experience it?," *Journal of Physics: Conference Series, IOP Publishing*, vol. 1663, no. 1, p. 012032, 2020. https://doi.org/10.1088/1742-6596/1663/1/012032

[23] D. Juniati and I. K. Budayasa, "The influence of cognitive and affective factors on the performance of prospective mathematics teachers," *European Journal of Educational Research*, vol. 11, no. 3, pp. 1379-1391, 2022. https://doi.org/10.12973/eu-jer.11.3.1379

[24] R. Wahyuni, D. Juniati, and P. Wijayanti, "Mathematics anxiety of junior high school students in solving geometry problems," *Prospects of Science and Education*, vol. 71, no. 5, pp. 452-463, 2024. https://doi.org/10.32744/pse.2024.5.26

[25] T. P. Alloway and R. G. Alloway, "Investigating the predictive roles of working memory and IQ in academic attainment," *Journal of Experimental Child Psychology*, vol. 106, no. 1, pp. 20-29, 2010. https://doi.org/10.1016/j.jecp.2009.11.003

[26] I. Friso-Van den Bos, S. H. Van der Ven, E. H. Kroesbergen, and J. E. Van Luit, "Working memory and mathematics in primary school children: A meta-analysis," *Educational Research Review*, vol. 10, pp. 29-44, 2013. https://doi.org/10.1016/j.edurev.2013.05.003

[27] H. Miller and J. Bichsel, "Anxiety, working memory, gender, and math performance," *Personality and Individual Differences*, vol. 37, no. 3, pp. 591-606, 2004. https://doi.org/10.1016/j.paid.2003.09.029

[28] A. García-Santillán, M. E. Escalera-Chávez, E. Moreno-García, and J. del Carmen Santana-Villegas, "Factors that explains student anxiety toward mathematics," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 12, no. 2, pp. 361-372, 2016. https://doi.org/10.12973/eurasia.2016.1216a

[29] C. Georges, D. Hoffmann, and C. Schiltz, "How math anxiety relates to number–space associations," *Frontiers in Psychology*, vol. 7, pp. 1–15, 2016. https://doi.org/10.3389/fpsyg.2016.01401

[30] I. Palengka and D. Juniati, "Mathematical reasoning of prospective mathematics teachers in solving problems based on working memory capacity differences," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 18, no. 12, p. em2193, 2022. https://doi.org/10.29333/ejmste/12670

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