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Level of creative thinking ability of students in solving numeracy problems

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ABSTRACT

Creative thinking plays an important role in the development of new ideas in mathematical solutions that are positively correlated with crucial 21st century skills. This study aims to determine the level of students' creative thinking skills in solving numeracy problems. The research subjects consisted of 30 fourth grade elementary school students in Central Bangka Regency, Bangka Belitung Islands Province. The research method used descriptive research with a qualitative approach. The data collection technique used a written test of 5 questions. The questions were based on the Minimum Competency Assessment (AKM) numeracy test from the Education Assessment Center (Pusmendik). The data test test were analyzed descriptively on the level of creative thinking ability. The results showed that 7% of students reached level 2 in creative thinking, able to solve with original solutions but did not reach fluency or flexibility. Most students reached level 0 and 1 respectively 53% and 40%, the solution did not meet the originality (novelty), fluency, and or flexibility. The low level of creative thinking of elementary school students illustrates that the learning process tends not to be on a new and flexible problem solving process, it is recommended to implement a learning model based on open problem solving or project-based learning that stimulates creative thinking skills.

INTRODUCTION

Creativity is a vital skill that students need to navigate the challenges of the 21st century. Advances in computers, technology and artificial intelligence, robots can now perform most daily tasks that previously required humans (Bicer, 2021). Creative thinking has therefore become a very important employability skill. Creative thinking is an activity that involves the ability to think by involving new ideas that are original, reflective, and produce a complex product (Krulik & Rudnick, 1999). Creativity as an ability reflects the fluency, flexibility and originality of thinking and the ability to elaborate to achieve success in solving problems (Adiansha et al., 2020). So that creative ideas can be developed through classroom learning and assessment.

Creative thinking contributes greatly to mathematics learning. Creative thinking is a person's capacity to generate new ideas, solutions or concepts that are original and valuable (Bicer et al., 2024). Originality of ideas is the main requirement for mathematical creativity arising from imagination, curiosity, and the courage to take risks from learning experiences (Bereczki & Kárpáti, 2021). Therefore, in the assessment of classroom learning, students need to be directed to foster creative ideas in solving mathematical problems. In schools, student creativity is reflected in creative expression, creative problem solving, and knowledge creation skills, which can be developed independently or used as learning topics in science, technology, mathematics, engineering, and other courses (Lucas & Venckutė, 2020). Creativity skills are useful in improving problem-solving and

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problem-posing skills (Sadak et al., 2022). So that in learning mathematics, it is necessary to provide problems that demand creativity.

Creative thinking is the ability to generate new ideas creatively. The creative thinking perspective is based on divergent thinking, focusing on flexibility, fluency, and novelty (Silver, 1997). Flexibility is the ability to generate multiple ways to find solutions. Flexibility of ideas is demonstrated by new, different, and unusual ideas (Bokhove et al., 2023). Originality of ideas refers to the novelty of individual responses, which is a key indicator of creativity (Habib et al., 2024). Originality of ideas is defined as the discovery of unusual, clever, and novel ideas (De Bloom et al., 2014). These three criteria become the framework for analyzing creative thinking skills, which are arranged based on the level of creative thinking skills.

One of the essential aspects that requires creative thinking skills is solving numeracy problems. Students are required to be able to formulate, apply, and interpret in solving problems in various real-world context (OECD, 2018). Starting in 2021 the PISA study tests innovative subjects-creative thinking (OECD, 2019). Learning that integrates numeracy and creativity, can develop critical and adaptive thinking skills, which are needed in this information age (Witono & Hadi, 2025). So it is necessary to study students' creative abilities in solving numeracy problems.

Research related to the ability to think creatively in solving numeracy problems has been documented by several previous researchers Fadlilah and Siswono, (2022) documented the ability to solve numeracy problems is measured from the creative thinking ability of assimilating and converging students. His research shows that students with assimilating learning styles tend to be creative compared to converging students, who are still quite creative. Putri and Awalludin, (2024) documented related to solving literacy and numeracy problems analyzed based on mathematical creative thinking ability based on a review of self-efficacy. The results prove that students who have low self-efficacy are only able to fulfill the fluency indicator, while students who have high and medium self-efficacy are able to fulfill the fluency, elaboration, and originality indicators. Said and Syamsuddin (2023) research related to the Effect of the Numeracy Literacy-Based Scientific Approach on Creative Thinking and Mathematical Communication Skills. The results provide a positive effect in improving creative thinking skills. However, there are still few studies related to numeracy problems measured by the level of creative thinking skills.

The contribution of this research lies in understanding the level of creative thinking ability which is important to know as a basis for improving student numeracy in learning mathematics in elementary schools. This study aims to determine the level of students' creative thinking skills in solving numeracy problems.

METHODS

Research design

A qualitative approach in the form of descriptive research was applied to describe the level of students' creative thinking ability in mathematics learning at elementary school (Creswell, 2014). The main focus of the research was on the level of students' creative thinking skills in solving numeracy problems. This research was conducted at a private elementary school in Central Bangka Regency, Bangka Belitung Islands Province, with 30 fourth-grade students as the research subjects. Ensuring that all subjects have an equal opportunity to participate in the research enhances the representativeness of the results (Cohen et al., 2018).

Data collection

The data collection technique used a written test. The test questions consisted of 5 numeracy questions that met the category of creative thinking questions, which included open-ended categories and connections to real life (Bicer et al., 2024). The test questions used are based on the Minimum Competency Assessment (AKM) test in the field of numeracy, which is open access from the Education Assessment Center (Pusmendik). One of the questions is shown in Figure 1.

One way to solve the problem in Figure 1 is to calculate the length of the circumference of the entire swimming pool by looking at the context in the problem. In the problem, it can be seen that the pool is rectangular, so the calculated length of the perimeter of the swimming pool is 1200 cm. So that if the perimeter of the pool is given a rough ceramic with a size of 10 x 10 (in cm) then the

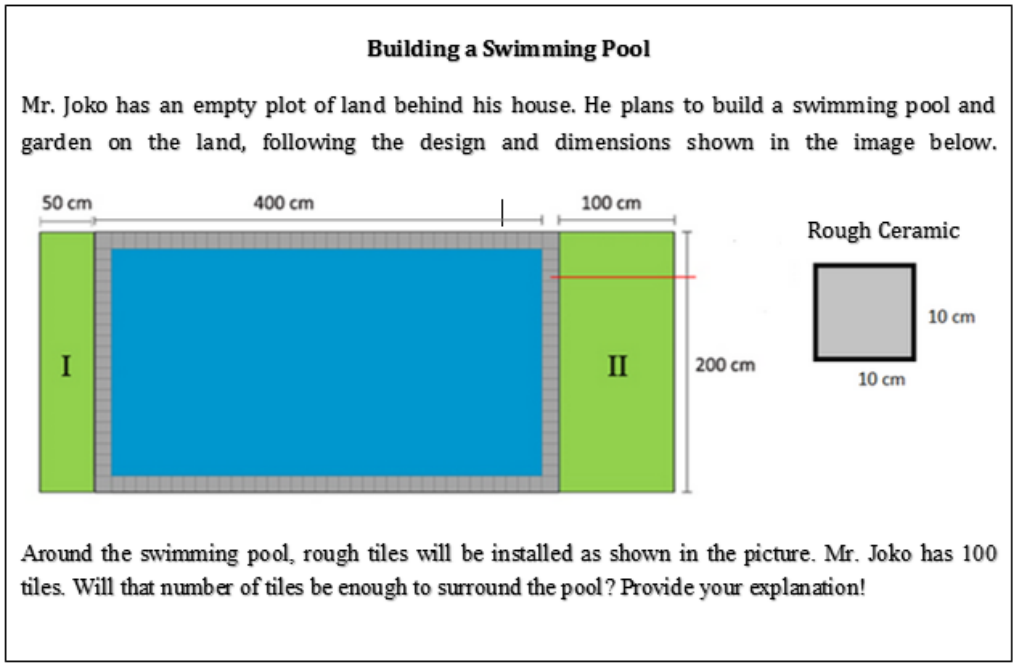

Figure 1. Test instrument

Table 1
Characteristics of creative thinking levels

Level	Characteristics of Creative Thinking Levels
Level 4 (Very Creative)	Students are able to solve problems with more than one solution and can represent other ways to solve them. One solution fulfills originality (novelty). Students can also propose new problems. One problem has different solutions and different methods to solve it. Some constructed problems fulfill the elements of novelty, fluency, and flexibility.
Level 3 (Creative)	Students are able to show all creativity criteria in synthesizing ideas to generate new ideas from mathematical concepts and apply these ideas. Characteristics of alternatives, can represent other ways to solve the problem, but not can create new solutions. On the other hand, it can also create a new problem. One problem has different solutions, but no different methods to solve it. or, it can be made divergent methods for one constructed problem but none of the problems met novelty.
Level 2 (Quite Creative)	Students can solve problems with one or two creative thinking criteria. Students are able to synthesize ideas from mathematical concepts or real-life experiences to generate new ideas. Students tend to understand that different methods or strategies to solve problems as other formulas with different representations..
Level 1 (Almost Not Creative)	Students are only able to solve problems with one or two creative thinking criteria. Students are unable to synthesize creative ideas. Problems tend to be mathematical in nature without connecting them with real life.
Level 0 (Not Creative)	Students do not fulfill all the criteria for creative thinking, cannot synthesize ideas. The solution does not fulfill originality (novelty), fluency, and flexibility.

largest possibility of ceramics needed is 120 pieces or as many as 118 pieces if at the end of the pool the ceramics do not overlap. So the 100 tiles that Mr. Joko has are not enough to be installed around swimming pool. The problem can be solved by adding up the length of the pool's perimeter and dividing by the length of the tiles, or by calculating the number of tiles needed for each perimeter length and adding up the number of tiles needed. In addition, students can also explore their

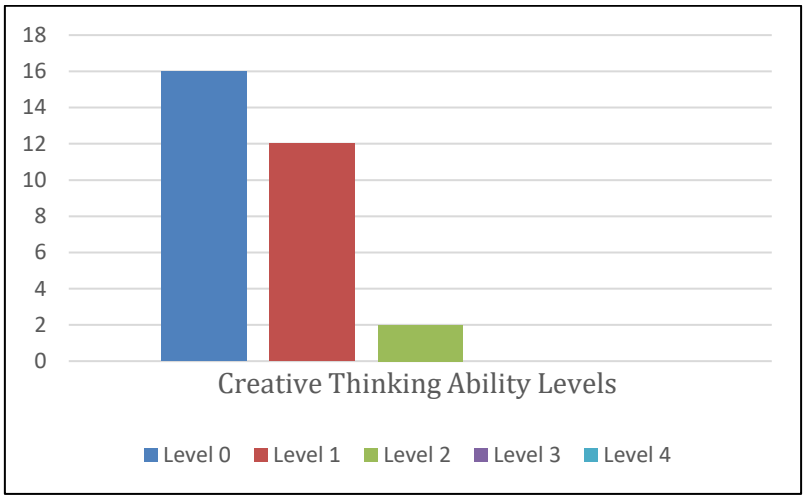

Figure 2. Diagram of students' creative thinking ability levels

creativity by sketching the circumference of the swimming pool by placing the length of the ceramic sketch on the circumference of the swimming pool.

Data analysis

The test data were analyzed descriptively on the level of creative thinking ability. Data was analyzed using the stages of data collection, data reduction, data presentation, and drawing conclusions (Miles & Huberman, 1994). While the level of students' creative thinking is based on Siswono (2011) which is presented in Table 1.

FINDINGS

Descriptive research using a written numeracy test was conducted with fourth-grade students. Descriptive analysis was used to reveal the level of students' creative thinking ability. The general research findings are presented in this section, specifically, the research results reveal the level of creative thinking, in the form of: 1) level 0 (not creative), 2) level 1 (almost not creative), and level 2 (quite creative).

The results of the tests conducted in general found that students' creative thinking skills were still far from what was expected. Students' creative thinking ability in solving numeracy is presented in Figure 2. It can be seen that students' creativity abilities have only reached level 2, with students being able to solve problems with one original solution but not fulfilling the requirements. fluency or flexibility, or there are students who can show other ways to solve a problem, but do not fulfil fluency and flexibility. Most only reached levels 0 and 1, with more than half of the subjects only reaching level 0, Students could not solve the problem in more than one way of solving and could not show other ways to solve it. Solutions did not meet the originality (novelty), fluency, and or flexibility. Students also cannot propose problems of novelty and flexibility. Errors made by students are caused by weaknesses in understanding related concepts.

For levels 3 and 4, which are classified as high levels of creativity, there are no students who reach that level. Students are not able to solve problems with more than one solution and can represent other ways to solve them. One solution fulfils originality (novelty). So it can be concluded that students' mathematical creativity skills are still low or need to be improved. This research is in line with the results of PISA 2015 that less than 0.8% of students were able to solve high-level problems, and reached 42.3% able to solve level 2 and below problems (OECD, 2016).

Level 0 (not creative)

In Figure 3, it can be seen that the three subjects only reached level 0 according to the ability of mathematical creativity. The three subjects could not solve the problem and could not show other ways to solve it. Like S1, who did not show mathematical creativity, although the answer shows that

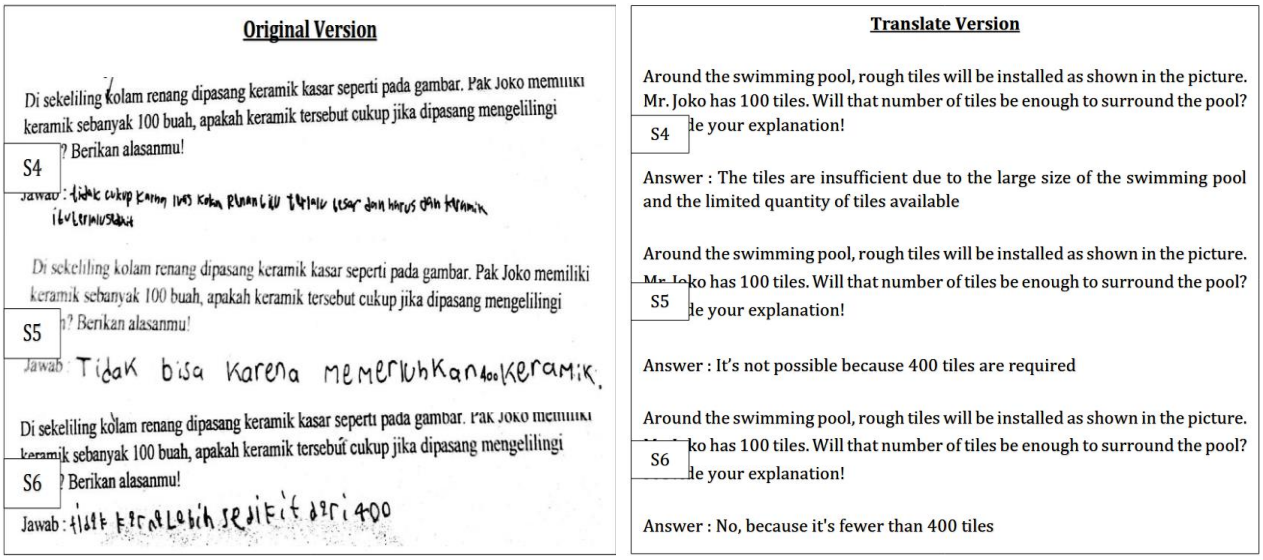

Figure 4. Answers of subjects S4, S5, and S6 that reach level 1

the subject considers that if the available ceramics are fewer, then they can buy more. Mathematically, this answer cannot be justified, even though it has reasoning in solving problems according to what is faced in everyday life. Furthermore, S2 used mathematical calculations in answering the problem, but there were errors in understanding the concepts related to the perimeter of flat shapes. Likewise, S3 solved the problem by using the possibility by looking at the perimeter of the pool, without any mathematical process.

Figure 3 explains that the three subjects could not synthesize new ideas mathematically in answering the problem. The errors made by students are caused by weaknesses in understanding related concepts.

Level 1 (almost not creative)

In Figure 4 it can be seen that the three subjects only reached level 1, the subject was able to solve with another solution but could not show another way to solve it. The solutions given did not meet the originality (novelty). For example, S4 answered that the number of tiles was not enough because the pool area was too large, but was unable to reach the next level by estimating numbers, formulas or solutions. S5 and S6, on the other hand, were able to involve numbers in solving the problem, but did not provide a formula or solution in answering it. Both subjects (S5 and S6) estimated the number of ceramics needed as many as 400, with many owned by Mr. Joko as many as 100 ceramics. So it can be concluded that there are not enough tiles if installed around the pool, but neither S5 nor S6 emphasized the number of 400 tiles needed, not based on a clear mathematical formula. Figure 4 explains that the three subjects only reached level 1 with the category of almost not creative. The three subjects could not synthesize their creative ideas in answering the questions given.

Level 2 (quite creative)

In Figure 2 and Figure 5 it can be seen that there are only 2 subjects reaching level 2, they can solve the problem with one original solution but do not fulfill fluency or flexibility, or can show other ways by arguing to solve a problem. As S7 gave the answer that there not enough tiles available to surround the pool, although in estimating using numbers based on the tiles needed more than 100, but did not use a formula in determining the number of tiles actually needed to surround the pool. Likewise, S8 can decide that the number of ceramics available is not enough when installed around the pool, although in answering the question using arguments based on numbers and formulas that should be, but less precise in providing appropriate answer solutions. So that in learning, teachers can stimulate students by asking questions related to the truth of the answer so that students realize their miscalculation (Fadlilah & Siswono, 2022). For example, S8 used the context of the area in

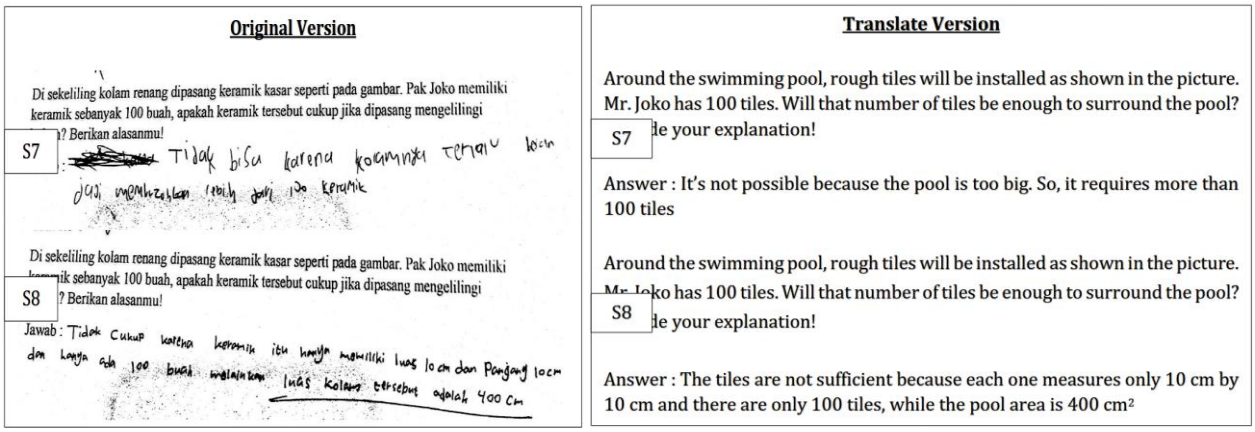

Figure 5. Answers of subjects S7 and S8 that reach level 2

answering the question obtained as long as 400 cm, but did not arrive at the solution that should be with a length of 400 cm can be installed as many as 40 tiles.

Figure 5 explains that students have not fulfilled fluency or flexibility in solving problems based on numbers and formulas in finding the correct answer solution. Students have been able to synthesize ideas from mathematical concepts to generate new ideas.

DISCUSSION

Students are unable to bring up all categories of creative thinking including novelty, fluency, and flexibility. The results of analyzing students' answers show that students tend to be weak in understanding mathematical concepts in solving problems. Furthermore, not many students reach level 2, although they can use creative ideas by bringing up novelty in answering problems, but not reach the criteria of fluency and flexibility. The results of analysing students' answers show that students tend to be unfamiliar with solving open-ended problems that require creative thinking. Different from previous research (Nabila & Amin, 2024) Both high and low self-efficacy students fulfilled all the indicators of creative thinking. However, the students had been taught the material in advance prior to the test. Each student generated varied responses in problem-solving, reflecting the three indicators of creativity: (1) fluency, (2) flexibility, and (3) originality (Fauziyah et al., 2021). However, the study titled Through Sharing and Jumping Task in Mathematics Lesson Study Activity showed an improvement in students' creativity. This research is focused on the students' test outcomes.

Creative thinking skills that are still relatively low in solving numeracy problems, especially in terms of fluency and flexibility, which are creative levels, indicate that there is a need for improvement in improving students' creative thinking. Strengthening numeracy and creative thinking skills in learning mathematics in elementary schools is a crucial factor in preparing students to face the challenges of life in the future (Witono & Hadi, 2025). Thus, the achievement of this level is expected to be an illustration of designing learning.

Most students' answers did not fulfil originality (novelty). Likewise, at high levels (level 3 and 4) none of the students achieved it. This study differs from the research of García-García et al. (2024) that there were 5.9% of participants who achieved high mathematical creativity, although it is still relatively small, the difference is due to the treatment of music training on mathematical performance and the role of creativity. In line with research related to student numeracy skills that have been conducted by several researchers, such as Sa'dijah et al. (2023) student numeracy skills being low, as many as 62% of students are at a poor level in solving numeracy problems. Students still have difficulty solving level 1 and 2 numeracy problems (Masfufah & Afriansyah, 2021). As many as 58% of grade 5 elementary school students have low numeracy literacy skills (Rahmwati, 2022). Unlike previous research (Slyamkhan et al., 2022) The distribution ratio of mathematical literacy dependence on basic thinking forms (objective, symbolic, and sign) is classified as high.

The learning process in the classroom plays an important role in improving students' creative thinking skills. Based on the results of research Saputra (2020) in the learning process at school, students have difficulty solving new problems in innovative ways as needed. So students need to be given problems that support creative thinking. In addition, the problem in the learning process is still low memorisation with creativity; the problem of learning mathematics is the delivery of information from teachers to students, which is memorised and has low creativity (Sholeh & Fahrurozi, 2021). Students need to have a high mathematical disposition to solve math problems that demand creativity (Patmalasari et al., 2017). Mathematical creative thinking among students frequently remains underdeveloped because of insufficient attention to non-cognitive factors (Suherman & Vidákovich, 2025). Therefore, students' creative thinking outcomes serve as points for future improvement.

Supporting the effective use of creativity in the classroom requires professional development for teachers that focusses on problems development that addressing creativity (Shodiq et al., 2025). The significance of designing pedagogical approaches to cultivate and evaluate creative competencies (Lu et al., 2025). By implementing tasks and activities, educators can foster various dimensions of students' creative abilities, including fluency, flexibility, and originality. So that there needs to be a breakthrough in the process of learning mathematics through activities and approaches that support students' mathematical creativity.

CONCLUSIONS

The results of data analysis show that students' creative thinking skills in solving numeracy problems are still relatively low. From ability levels 0 to 4, students with good creative thinking skills only reached level 2 (quite creative). There are no students who have reached level 3 or 4. Most students still reach the lower levels (level 0 and level 1). This indicates that, in the learning process students need to improve their creative thinking skills. So this research is expected to be a reference material for teachers to design learning according to the level of students' creative thinking abilities, which still feels difficult in its application.

Based on the results of the analysis, it shows that in solving problems that are open-ended or open questions, it is important for students to have good creative thinking skills. Suggestions for teachers in designing numeracy-oriented learning can start from concept understanding questions first, but go to open-ended creative thinking questions and connect with real life. Although there is no research that states the percentage of creative thinking skills in solving numeracy problems, this ability is important in solving numeracy problems.

This study is limited to the number of subjects in only one school, so it does not represent the results at the national level. In addition, this research is limited to qualitative descriptive results describing the level of students' creative thinking skills in solving numeracy problems. Future research should expand by adding research subjects from schools in various regions to get a nationally representative picture of creative thinking skills in solving numeracy problems. Future research is recommended to use other approaches that can determine the relationship of various factors, such as quantitative or mixed methods. It can also be research to develop more diverse instruments to enrich the results of the study.

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AUTHOR'S DECLARATION

Authors' contributions : All authors contributed to the concept of the research. YYP: initiating the main idea and concept of the research, data collection and reporting. IFR: data analysis, review and editing. ABJS: review and editing.

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