Analysis of Students' Creative Thinking Ability in Solving HOTS Problems Viewed from Numeration Ability

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Abstrak

Salah satu tujuan pembelajaran matematika untuk memecahkan masalah matematika dengan lebih dari satu penyelesaian. Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir kreatif matematis siswa dengan kemampuan berhitung tinggi, sedang, dan rendah dalam menyelesaikan soal SPLDV. Subyek penelitian ini adalah siswa kelas VIII.7 SMP Negeri 3 Surakarta yang berjumlah 32 siswa. Pendekatan penelitian ini adalah deskriptif kualitatif. Instrumen yang digunakan dalam penelitian ini adalah tes berhitung, tes berpikir kreatif matematis, dan pedoman wawancara. Indikator kemampuan berpikir kreatif matematis yang diukur meliputi kelancaran, keluwesan, orisinalitas, dan elaborasi. Teknik analisis data yang digunakan dalam penelitian ini menggunakan tiga cara untuk menganalisis data, yaitu reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa kemampuan berhitung siswa dengan kategori tinggi memiliki kemampuan berpikir kreatif yang baik. Siswa dapat memenuhi aspek kelancaran, keluwesan, orisinalitas, dan elaborasi. Kemampuan berhitung siswa dengan kategori sedang memiliki kemampuan berpikir kreatif yang relatif baik. Siswa dapat memenuhi aspek kelancaran, keluwesan, dan elaborasi tetapi belum memenuhi aspek orisinalitas. Kemampuan berhitung siswa dengan kategori rendah memiliki kemampuan berpikir kreatif yang kurang baik. Siswa belum memenuhi aspek kelancaran, keluwesan, orisinalitas, dan elaborasi. Dapat disimpulkan bahwa kemampuan berhitung menentukan kemampuan berpikir kreatif matematis siswa.
Kata Kunci: Berpikir Kreatif Matematis; Kemampuan Berhitung; HOTS.

Abstract

One of the goals in learning mathematics to solve mathematical problems with more than one solution. This research aims to describe the mathematical creative thinking ability of students with high, medium, and low numeracy skills in solving SPLDV problems. The subject of this study were 32 students of grade VIII.7 at SMP Negeri 3 Surakarta. The approach to this study is a qualitative description. The instruments used in this research were a numeracy test, a mathematical creative thinking test, and an interview guideline. Mathematical creative thinking ability indicators measured include fluency, flexibility, originality, and elaboration. The data analysis technique used in this study uses three ways to analyze data, namely data reduction, data presentation, and conclusion drawing. The results showed that the numeracy ability of students with high categories has good creative thinking skills. Students can meet the aspects of fluency, flexibility, originality, and elaboration. The numeracy ability of students with medium categories has a relatively good creative thinking ability. Students can meet the aspects of fluency, flexibility, and elaboration but have not fulfilled the originality aspect. The numeracy ability of students with low categories has poor creative thinking skills. Students have not met the aspects of fluency, flexibility, originality, and elaboration. It can be concluded that numeracy skills determine students' mathematical creative thinking ability.
Keywords: Mathematical Creative Thinking; Numeracy Ability; HOTS.

I. INTRODUCTION

Education is an attempt to improve the quality of human resources. School is one of the pathways to education. Mathematics is the foundation of knowledge in every branch of science. Therefore mathematics plays an essential role in education (Khairunnisa & Setyaningsih, 2017). According to the classification of scientific fields, mathematics is an exact science that requires more creative thinking than memorization (Aripin & Purwasih, 2017). Mathematics is integral in school because it teaches the ability to think logically, analytically, systematically, critically, creatively, and collaboratively (Sutama, 2019). So, students not only have to answer questions or memorize formulas, they need skills or abilities to learn. One such skill is the ability to think creatively.

The ability to think creatively is one of the goals of learning mathematics. According to Fadlilah & Siswono (2022), Creative thinking is an individual activity that combines logical thinking to find problem solutions to produce innovative new products. Creative thinking is one of the high-level thinking skills to process thoughts and produce new views (Nurlaela et al., 2019). Meanwhile, according to Ristontowi & History (2020), creative mathematical thinking is the ability to find new and diverse solutions to mathematical problems that are open. Based on some of the definitions above, it can be concluded that creative mathematical thinking is the ability of higher-order thinking to process ideas to produce new diverse and innovative ideas.

The ability to think creatively is essential for everyone to compete in the era of a global society. In the era of globalization, technological and information advances are developing very rapidly, and individuals are competing for a better life (Maryati & Nurkayati, 2021). Creative thinking encourages individuals to achieve and develop themselves (Fadlilah & Siswono, 2022). Creativity is essential to deal with problems in everyday life. Of course, these problems are not all mathematical problems, but mathematics plays a central role in answering these everyday problems (Ristontowi & Sejarahi, 2020).

The new product produced by creative thinking is called creativity (Sari & Afriansyah, 2022). According to Van Harpen & Sriraman (2013), creative thinking ability can be divided into three categories: fluency, generating many ideas in different categories or domains. Ingenuity has new ideas to solve problems. Elaboration is detailed problem-solving skills. Isaksen and Treffinger (Fitriarosah, 2016) define creative thinking as building ideas, emphasizing fluidity, flexibility, novelty, and detail. This study's mathematical creative thinking ability index has four aspects: fluency, flexibility, originality, and elaboration.

But in practice, students' mathematical thinking ability has not been fully realized. Students' creative thinking ability about mathematics when working on the material provided by the teacher is limited by questions used as examples to understand concepts. It is easier for students to learn using question types similar to the sample questions and rarely use different questions, so students' creative thinking ability does not develop optimally (Ramadhani et al., 2021). Creative thinking

skills can be trained during the learning process. This aligns with Anwar's (2012) statement: "Creative thinking is categorized as something we are born with, but others say it can be developed through teaching activities and strategies." Creative thinking is categorized as something carried out from birth, but in the learning process, creative thinking can be achieved through learning activities and teaching strategies (Rozi & Afriansyah, 2022). School education is inseparable from the learning process and interaction between teachers and students (Setyaningsih & Rejeki, 2016). This shows that creative thinking can be developed through education.

One way is to provide higher-order thinking skills (HOTS) math problems. The provision of math problems that require students to think within the framework of HOTS is considered a way that students do not rely on formulas in solving problems (Ernaningsih & Wicasari, 2017). HOTS-type math problems have several characteristics, including measuring high-level thinking skills, context-based questions, and using various forms of questions. However, there are some obstacles in school, questions tend to test memory, and students' high-level thinking skills are not trained, so the creative thinking ability of Indonesian children is still relatively low. The 2015 International Trends in Mathematics and Science Research (TIMSS) survey results ranked Indonesia 45th out of 50 participating countries, with a mathematics score of 397 out of 500. (Rahmawati & Nizam, 2019). Therefore, one of the contributing factors is the lack of training of Indonesian

students in problem-solving to measure HOTS (Budiman & Jailani, 2014).

One solution, in addition to practicing doing HOTS problems, is to improve the ability to think creatively and mathematically. Students also need to improve their calculation skills, namely by improving numeracy skills. Numeracy is the ability to think of everyday problems using concepts, procedures, facts, and mathematical tools (Sari et al., 2021). Numeracy involves higher-order thinking skills. The solving of numeracy skills needs to be carried out with a systematic stage. According to Polya (1973), the problem-solving phase can be solved by understanding the problem, planning, implementing a problem-solving plan, and conducting a review. Completing these stages helps give students an overview and guides them in formulating and applying problem-solving approaches to examining answers (Kevin A. Artuz & B. Roble, 2021). Students with high numeracy skills can solve mathematical problems using various numbers and symbols related to basic mathematics, analyze information in graphs, tables, charts, and others, and use this information to solve problems (Maulidina & Hartatik, 2019). Therefore, students with high numeracy skills will be able to solve mathematical problems well.

Based on the explanation of the theory and opinions above, it is necessary to study students' mathematical creative thinking ability in solving Higher Order Thinking Skills (HOTS) problems in terms of numeracy abilities. The test to be applied in this study uses two-variable linear equation system (SPLDV) material in the form of

story problems. The material in a system of two-variable linear equations (SPLDV) can be used in identifying the creative thinking ability of students with high, medium, and low numeracy abilities.

II. METHOD

This research is qualitative descriptive research (Sugiyono, 2020). The subjects of this research were 32 students who were carried out in class VIII.7 of SMP Negeri 3 Surakarta for the 2022/2023 school year. The main instruments are researchers and supporting instruments include numeracy skills, mathematical creative thinking problems, and interview guides. The numeracy ability test question instrument contains 20 multiple-choice questions and Higher Order Thinking Skills (HOTS) question type mathematical creative thinking ability test questions with Two Variable Linear Equation System (SPLDV) material in the form of story questions containing 2 description questions. Before use, the test questions are validated by the mathematics teacher of SMP Negeri 3 Surakarta. The validation results are as follows:

Karangasem Village is organizing a cultural festival. Mr. Mamat, a Karangasem resident, took advantage of this activity to open a parking lot. There are 100 vehicles consisting of motorbikes and cars. If you count the overall wheels, there are 278 pieces. The parking fee for a motorbike is IDR 3,000.00, while the parking fee for a car is IDR 5,000.00. What is the amount of parking money income from the existing vehicle?

To clarify the results of the answers, students also conducted interviews to get

information about the creative mathematical thinking of the subjects after the test, namely, only students who met the criteria for high, medium, and low numeracy ability. Data analysis is obtained directly from the field: data reduction, data presentation, and conclusion. Data reduction in this study consisted of recording the results of interviews related to students' mathematical creative thinking skills after solving Higher Order Thinking Skills (HOTS) questions. The data presentation stage in this study includes the presentation of student work used as interview material and the presentation of interview recordings related to students' mathematical creative thinking skills. Based on the results of the presentation of the data, then an analysis is carried out which is then presented in the form of a narrative. In this research, researchers draw conclusions from the analysis of student test results and interview results. In order to test the validity of the data, triangulation techniques were used in this study.

III. RESULT AND DISCUSSION

Based on the numeracy ability test results from thirty-two grade VIII.7 students of SMP Negeri 3 Surakarta, the numeracy ability test results are categorized as high, medium, and low. To categorize the results of the numeracy ability test according to Azwar (2012) as shown in Table 1 as follows:

Table 1.
Selected Subject

Interval Value	Category
≥ 75	High
50 ≤ x < 75	Medium
< 50	Low

There are sixteen students with high numeracy, fourteen with medium numeracy, and two with low numeracy. In this study, researchers only took two subjects for each category, so there were six subjects taken, as shown in Table 2 as follows:

Table 2.
Selected Subject

Subject Code	Category
S-1	High
S-2	High
S-3	Medium
S-4	Medium
S-5	Low
S-6	Low

The selected subjects are then interviewed to learn more about students' mathematical creative thinking abilities. Here are the results of the observation of the six subjects:

A. First Subject (S-1)

Based on the results of the work and interviews, S-1 has good mathematical creative thinking skills, as shown in Figure 1 and the interview results:
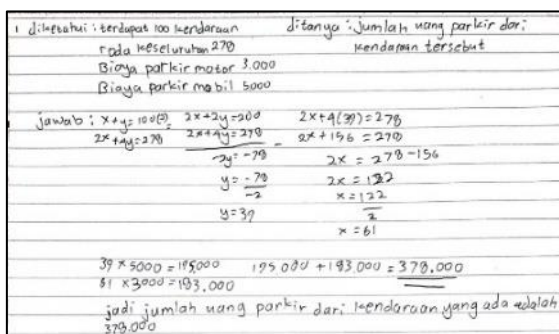

Figure 1. Answer S-1

P   : What do you understand and know after reading the questions?

S-1   : Discusses SPLDV. It is known that there are one hundred vehicles, the total number of wheels is two hundred and seventy-eight, the number of

motorcycles is IDR 3,000.00, and the car parking rate is IDR 5,000.00. I asked about the parking levy income that Mr. Mamat received.

P   : What method did you use to solve this problem?

S-1   : Using mixed methods. First, I eliminate the value, then after finding the value y, I substitute to the equation $x + y = 100.$ After getting the value and multiplying it by the parking fee, $\big((x \times 3.000) + (y \times 5.000)\big).$

P   : Is there any other event to solve the problem?

S-1   : There is, with the elimination method, substitution only, or with the graph method, it is more complicated.

P   : What conclusions can you get after doing the questions?

S-1   : In conclusion, the amount of money earned by Pak Mamat is IDR 378,000.00

S-1 can understand problems in the form of stories precisely, correctly, and clearly. During the interview, S-1 could answer the questions smoothly, showing that S-1 meets the fluency aspect. At the interview, the S-1 can present many varied ways to solve the problem, as well as be able to mention different variables for providing motorcycles and cars. This shows that the S-1 meets the flexibility aspect. S-1 can give answers in its calculation, and the result is correct. This shows that the S-1 is sufficient for the originality aspect. S-1 can answer questions in detail. Writing is known, asked, answered, and concludes the problem's solution. This shows that S-1 meets the elaboration aspect. The explanation above shows that S-1 has achieved fluency, flexibility, originality, and elaboration.

B. Second Subject (S-2)

Based on the results of the work and interviews, S-2 has good mathematical creative thinking skills, as shown in Figure 2 and interview results:

Figure 2. Answer S-2

P   : What do you understand and know after reading the questions?

S-2   : It is known that there are one hundred vehicles, the number of wheels is two hundred and seventy-eight pieces, the motorbike parking fee is IDR 3,000.00, and the car parking fee is IDR 5,000.00. Asked for the sum of the entire parking money income.

P   : What method did you use to solve this problem?

S-2   : The trick is to eliminate x from the equations $x + y = 100$ and $2x + 4y = 100$. Then after getting the value of y, substitute it into the equation $x + y = 100$. By assuming the value of x for a motorcycle (2-wheeled) and y for a car (4-wheeled).

P   : Is there any other event to solve the problem?

S-2   : using the chart and elimination method only or substitution only.

P   : What conclusions can you get after doing question?

S-2   : The value is multiplied by the motorbike parking fee, and the value is multiplied by the car parking fee. So, the parking money income earned by Mr. Mamat is IDR 378,000.00, with the value and $((x \times 3.000) + (y \times 5.000)).x = 61 y = 39.$

S-2 can understand the problem correctly and clearly. When the S-2 interview also answered the questions smoothly. This shows that the S-2 meets the fluency aspect. The S-2 can solve problems by presenting different ways. This indicates that S-2 fulfills the flexibility aspect. After the interview, S-2 can write down the answers in a new way by combining various methods. Thus, S-2 was able to fulfill the element of originality. S-2 can answer questions in detail. The S-2 meets the elaboration aspect. Based on the explanation above, S-2 has achieved fluency, flexibility, originality, and elaboration.

C. Third Subject (S-3)

Based on the results of the work and interviews, S-3 has a reasonably good mathematical creative thinking ability, as shown in Figure 3 and interview results:

Figure 3. Answer S-3

P   : What do you understand and know after reading the questions?

S-3   : Membahas about how much Mr. Mamat's parking income is because there is a festival event in Karangasem Village. It is known that there are one hundred vehicles, the total number of wheels is two hundred and seventy-eight pieces, motorbike parking is IDR 3,000.00, and car parking is IDR 5,000.00.

P   : What method did you use to solve this problem

S-3   : Using mixed methods, namely elimination and substitution. First, I generalized the value of x for motorcycles and y for cars. After getting the x and y values, multiply them by the motorcycle and car parking

fees.

P   : *Is there any other event to solve the problem?*

S-3   : *Nothing like that.*

P   : *What conclusions can you get after doing the problem?*

S-3   : *In conclusion, the amount of money that Mr. Mamat received was IDR 422,000.00 with a value of $x = 61$ and $y = 39$.*

P   : *Try to check again if the answer is correct.*

S-3   : *Yes. My answer is wrong. The total income earned by Pak Mamat should be IDR 378,000.00.*

S-3 can understand the meaning of the problem and solve the problem clearly, but the result is not quite right. During the interview, S-3 can answer questions smoothly. This shows that the S-3 is sufficient to meet the fluency aspect. S-3 could not solve the problem differently but could offer the solution by assuming variables other than x and y. S-3 was a little confused when asked if there was another way to solve the problem. This shows that S-3 powerfully fulfills the flexibility aspect. S-3 has not been able to demonstrate completion in its way of thinking. This shows that the S-3 has not sufficiently met the originality aspect. S-3 can answer questions in detail. Writing is known, asked, answered, and concluded the solution to the problem, even if the results are not quite right. This shows that S-3 meets the elaboration aspect. The explanation above shows that the S-3 is sufficient to have aspects of fluency, flexibility, and elaboration but not enough aspects of originality.

D.   Subject Four (S-4)

Based on the results of the work and interviews, the S-4 has a reasonably good mathematical creative thinking ability, as shown in Figure 4 and interview results:

Figure 4. Answer S-4

P   : *What do you understand and know after reading the questions?*

S-4   : *The matter discusses Mr. Mamat's income earned from parking. It is known that the number of vehicles is one hundred, the number of all wheels is two hundred and seventy-eight, the motorbike tariff is IDR 3,000.00, and the car tariff is IDR 5,000.00. Then obtained the equation $x + y = 100$ and $2x + 4y = 278$*

P   : *How do I solve the problem?*

S-4   : *Using the elimination and substitution method. First, I eliminated the x value, then after getting the y value, I substituted it into the equation $x + y = 100$*

P   : *Is there any other event to solve the question?*

S-4   : *By way of graphics.*

S-4 was able to understand the question of the question, but the results were not quite right. During the interview, S-4 can answer questions smoothly. This shows

that the S-4 adequately meets the fluency aspect. S-4 has not been able to show different ways of solving the problem, but during the interview can present different ways, although the answers are correct. This shows that the S-4 is sufficient to meet the flexibility aspect. S-4 has not been able to demonstrate completion in its way or thought. This shows that the S-4 has not sufficiently met the originality aspect. S-4 can answer questions in detail. This shows that the S-4 meets the elaboration aspect. Based on the explanation above, it shows that the S-4 has enough aspects of fluency, flexibility, and elaboration, but it does not have enough aspects of originality.

E.   Subject Five (S-5)

Based on the results of work and interviews, S-5 has poor mathematical creative thinking skills, as shown in Figure 5 and interview results:
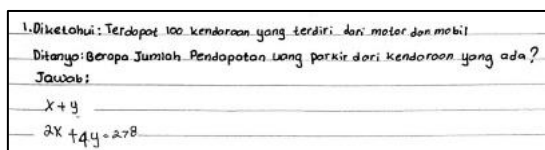

Figure 5. Answer S-5

P   : What do you understand and know after reading the question?

S-5   : It is known that the number of vehicles is 100, the number of all wheels is 278, the parking fee for one motorbike is IDR 3,000.00, and the parking fee for one car is IDR 5,000.00. Asked the amount of Mr. Mamat's parking money income.

P   : Why can't you solve the problem to the end?

S-5   : Confused, I still don't understand.

S-5 has not been able to analyze the problem well. During the Interview, S-5 can already mention what is known in the question, but in the answer sheet, S-5 does not write down what is known entirely and has not been able to solve the problem

because S-5 is still confused about the problem given. It is concluded that S-5 has not yet achieved fluency, flexibility, originality, and elaboration.

F.   Sixth Subject (S-6)

Based on the results of work and interviews, S-6 has poor mathematical creative thinking skills, as shown in Figure 6 and interview results:
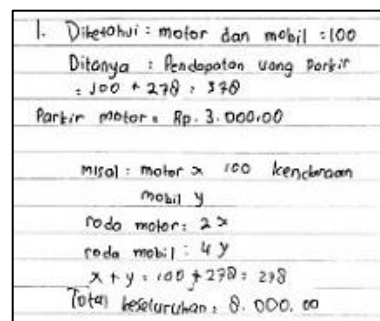

Figure 6. Answer S-6

P   : What do you understand and know after reading the questions?

S-6   : The matter of discussing how much Mr. Mamat's parking income is because there is a festival event in Karangasem Village. It is known that the number of vehicles is one hundred, the total number of wheels is two hundred and seventy-eight, motorbike parking is IDR 3,000.00, and car parking is IDR 5,000.00.

P   : How do I solve the problem?

S-6   : Confused, I've forgotten how.

S-6 has not been able to analyze the problem well and still has difficulty solving it, even though it has written down what is known about the problem and tried to make a mathematical model. S-6 has not achieved fluency, flexibility, originality, and elaboration.

Based on the results of the research presented above, the discussion of the mathematical creative thinking ability of class VIII.7 students of SMP Negeri 3 Surakarta on the algebraic material on the

subject matter of the two-variable linear equation system (SPLDV) is as follows:

In the ability of students' mathematical creative thinking in solving HOTS questions in terms of high category numeracy skills, they can meet four aspects of mathematical creative thinking ability, namely aspects of fluency, flexibility, originality, and elaboration. As can be seen, students can fulfill the element of smoothness. Students do not experience difficulties working on problems, can analyze problems smoothly and accurately, provide information in the form of known and asked questions, and can use appropriate methods to solve problems. This is in line with research by Thanheiser (2021), which states that students who think creatively can quickly understand concepts in learning materials.

Further, in this category, students can show flexibility in answering questions. Students can demonstrate answers in a variety of ways to solve the problem. This is in line with Syahara and Astutik (2021) research, which shows that students can solve math problems differently and arrive at the right solution. In terms of originality, students can answer questions with their ideas. Ingenuity is significant for students to combine approaches to problem-solving. This is in line with the research carried out by Radford (2009), which states that when solving a problem you encounter, you do not have to solve it in the usual way but sometimes must be able to provide the solution yourself.

It further said that in this category, students could fulfill the elaboration aspect in the high numeracy ability category. This

is shown by students being able to understand the problem in detail, precisely, and thoroughly and can illustrate it by using the issue to answer the questions asked, as well as being able to write known, requested, and concluded solutions to the problem.

In the ability of creative mathematical thinking, students in solving HOTS questions in terms of medium category numeracy ability can achieve fluency, flexibility, and elaboration, but not enough aspects of originality. In the medium category, students can answer questions and are still encountered students with difficulties. Students can understand the questions well, but the answers written are still not correct, and they can show the miscalculations made. So, it can be said that students with medium categories are pretty familiar with the fluency aspect of creative mathematical thinking. In flexibility, students can complete the proper steps, but the answers written are still not correct. So, students with a medium numeracy category are enough to meet the flexibility aspect.

It further said that in this category, students have not been able to show the originality aspect because students have not been able to solve in a new way, and there are still some mistakes. In the elaboration aspect, students can understand the problem in detail, but it has not been thorough. Students can fulfill the elaboration aspect because they can write down what is known, ask, and conclude the solution to the question. In line with the research of Maryati and Nurkayati (2021) its research showing the results that the

ability to have creative thinking ability is a good category, based on indicators of creative thinking ability (i) fluency of thinking including the good category, (ii) including the category of lacking, (iii) authenticity including the category of sufficient, and (iv) thinking elaboration is included in the category of sufficient.

The students' mathematical creative thinking ability related to low arithmetic shows that the four aspects of students' mathematical creative thinking are not all achieved. Students in this category are not yet able to solve tasks correctly. They can write what is known and asked in the problem and write a linear equation model in two variables, but they cannot understand the question given. Students with low numeracy skills have not achieved fluency, flexibility, originality, or elaboration in mathematical creative thinking ability. This research is in line with the research conducted by Prastika et al. (2021). His research concluded that students with low mathematical logic intelligence are at level zero in thinking creatively (not creatively). Students cannot meet fluency, flexibility, originality, or elaboration aspects in mathematical creative thinking skills.

IV. CONCLUSION

Based on the findings, results and discussion, it can be concluded that numeracy skills determine students' mathematical creative thinking ability. Students with the high numeracy ability category have a good level of creative thinking because students can achieve all four indicators of creative mathematical thinking: fluency, flexibility, originality, and

elaboration. Students with a medium numeracy ability category have a reasonably good level of creative mathematical thinking. Students with the medium numeracy category could fulfill the aspects of fluency, flexibility, and elaboration but not enough to satisfy the element of originality. Students with low numeracy skills have low creative thinking skills because students in this category cannot fulfill the aspects of fluency, flexibility, originality, and elaboration. The ability to think creatively mathematically is the ability to find varied, novel solutions to open-ended mathematical problems easily and flexibly. Through mathematics learning activities can encourage students to be able to find problems and elaborate them by proposing guesses and planning solutions, students are facilitated in order to explore various alternative solutions and their implications and collect and distribute information. In addition, students are trained to habitually reflect on the effectiveness of their way of thinking in solving problems. It can be concluded that numeracy skills determine students' mathematical creative thinking ability.

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