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Analysis of High School Students' Mathematical Creative Thinking Ability Levels in Solving Mathematical Problems

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Abstract. Mathematical creative thinking ability is an important ability that must be possessed in the 21st century. This study aims to obtain an overview of the level of students' mathematical creative thinking abilities. The research sample was 31 students of class XI MIPA 1. This type of research is qualitative research. The instrument used is a test of the description of creative thinking skills, observation, documentation, and interviews. Data analysis techniques are carried out by reducing data, presenting data, and drawing conclusions and using triangulation techniques. The results showed 3 students were at the level of creative thinking ability level 4 (very creative), 5 people were at level 3 (creative), 10 people were at level 2 (less creative) and 13 people were at level 1 creative thinking ability (less creative).

Key words: Mathematics; Problem; Mathematical Creative Thinking Skill

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INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential. Education is an important thing for the progress of the country because education plays an important role in developing human intellectual abilities to create quality human resources so that it is expected to be useful for the nation and state. The era of technology is important in today's learning world (Latifah, 2014; Suryadi, 2015; Restiana, 2019).

Mathematics is one of the subjects that students really need to facilitate in getting qualified skills for mastering science and technology. Rachman & Amelia (2020) stated that mathematics is a means of scientific thinking, playing a very important role in the development of science and technology. Students' difficulties in learning mathematics are a problem in the world of education (Mayasari, 2016; Sulastri, 2013; Inayah, 2020; Suwarto, 2018).

Thinking is a mental activity experienced by a person when they are faced with a problem or situation that must be solved (Siswono, 2018). One of the thinking skills in Mathematics is the ability to think creatively. The ability to think creatively is very important for everyone in this current era, not only when studying at school but also when facing the world of work (Maharani, 2017; Wahyudi, Waluya, Rochmad, & Suyitno, 2018). The ability to think creatively is one of the higher-order thinking skills that must be developed in students and is one of the goals of learning mathematics. Creative thinking is also the ability to solve with various answers to one question (Mulyaningsih & Ratu, 2018). Creative thinking is a mental activity to increase originality and insight in developing something (Suriany, 2016). Mathematical creative thinking ability is the ability of students to understand and solve a problem in mathematics with strategies and ways that vary (divergent) so that the creative thinking process can be used for students' mathematical problem solving process directly precisely and quickly (Dilla, 2018). La Moma (2015) states that creative thinking is a mental activity related to sensitivity to a problem, considering new information and unusual ideas with an open mind, and being able to make connections in solving a problem.

Indonesian students have participated in the Trends in International Mathematics and Science Study (TIMSS) in 2015 with the results not showing much change in each participation. Indonesia only ranks 45 out of 50 countries with an average score of 397, which puts Indonesia in the top 6 from the bottom along with Jordan, Saudi Arabia, Morocco, South Africa, and Kuwait (Septian & Rizkindi, 2017).

Mathematics subjects need to be given to all students starting from elementary school, to equip students with the ability to think logically, analytically, systematically, critically, innovatively and creatively, as well as the ability to work together. These competencies are needed so that students can have the ability to obtain, manage, and utilize information to live better in

conditions that are always changing, uncertain, and competitive. In carrying out mathematics learning, it is expected that students should be able to feel the benefits of learning mathematics.

One of the international mathematics education organizations through the National Council of Teachers of Mathematics (NCTM) in Rosliana also stated that there are several aspects included in the ability to think mathematically including the ability to understand, mathematical problem solving, mathematical communication, mathematical reasoning and proof, mathematical connections. and mathematical representation. From these objectives in studying mathematics students are required to have mathematical creative thinking skills in solving mathematical problems (NCTM, 2000).

With regard to the term creative thinking, some experts define it in various ways. Rhodes (Nur, 2016) defines creativity by analyzing its four dimensions known as "the Four P's of Creativity, or "the four P's of creativity" namely Person, Product, Process, and Press. Bahar and Maker (2011) state that creative thinking in mathematics is the ability to generate new solutions to problems and apply mathematical principles in many different ways to produce correct solutions. There are several aspects to determine the creative thinking ability of students in solving mathematical problems. In the sense that creativity is a process that includes thinking skills which include: fluency, flexibility, originality, and elaboration (Hendriana, 2018). Andiyana (2018) defines creative thinking aims to create or find new ideas that are different, uncommon, original that bring definite and precise results. Meanwhile, according to Lestari & Zanthy (2019) the ability to think creatively mathematically is an ability in learning to build ideas or ideas and solve mathematical problems which include fluency, flexibility, originality and elaboration. So it can be concluded that mathematical creative thinking ability is the ability to create, discover, build new (original) ideas or ideas in solving mathematical problems which include fluency, flexibility, originality and elaboration for the purpose of definite and precise results.

The results of previous studies include stating that the skills of teachers and students in creative thinking are in the low category (Rosmaiyadi, 2017). Students' creative thinking skills are classified as low as seen from the low problem solving ability of students. This is in accordance with the results of an initial study on high school students in Garut. In the learning process when students are given non-routine practice questions, most students have difficulty and do not work on problems when faced with solving mathematical problems. The difficulty is because students are still not familiar with non-routine questions and also because students' creative thinking skills are still low.

Based on the description above, researchers are interested in analyzing students' mathematical creative thinking skills on linear programming material. The purpose of this study was to analyze students' mathematical creative thinking skills in solving problems related to the Linear Program material.

METHODS

This study uses a qualitative approach with a descriptive method. The research aims to describe students' creative thinking skills through the answers given without any manipulation (Sugiyono, 2020). The subjects of this study were students of class XI MIPA at SMA Negeri Batam. The scope of the material used is linear programming material. The data in this study are the results of the analysis of the level of mathematical creative thinking at each level of creative thinking ability. The data collection technique used a creative thinking ability test and a mathematical creative thinking interview guide. Furthermore, the data were analyzed descriptively. For data on students' creative thinking skills, the percentage formula is as follows:

$$score = \frac{student's\ score}{maximum\ score} \times 100\%$$

The rubric for scoring creative thinking skills is viewed from the indicators of fluency, flexibility, originality, and elaboration which are the result of modifications (La Moma, 2015). The error rate percentage grouping can be seen in the following table.

Table 1. Creative Thinking Indicator Percentage

No	Percentage	Category
1	$0 \leq P_i \leq 20$	Very low
2	$20 \leq P_i \leq 40$	Low
3	$40 \leq P_i \leq 60$	Adequate
4	$60 \leq P_i \leq 80$	High
5	$80 \leq P_i \leq 100$	Very high

RESULTS AND DISCUSSION

Developing the ability to think logically, analytically, systematically, critically and

collaboratively is the focus and attention of mathematics education in schools, because it is related to the nature and characteristics of mathematics. However, the focus and attention on efforts to improve creative thinking skills in mathematics learning is still rarely developed.

Siswono (2007) defines creative thinking ability as an ability that a person uses in synthesizing (weaving) ideas, building new ideas and applying them to produce new products fluently (fluency) and flexibly. Creative thinking ability can be measured by several criteria. Silver (1997) explains that to assess the creative thinking ability of children and adults can be done using "The Torrance Test of Creative Thinking (TTCT)". The three key components assessed in creative thinking using the TTCT are fluency, flexibility and novelty.

Siswono adapted the test measuring instrument from Silver by using the same three key components. Fluency refers to the ability of students to provide a variety of answers, flexibility refers to the ability of students to solve problems not only in one way but can provide another way, and novelty refers to the ability of students to pose a problem that different from the problem posed previously.

From the results of scoring on the results of student work, the average percentage of each indicator of creative thinking is presented in the following table:

Table 2. Creative Thinking Indicator Recapitulation

No	Indicator	Average (%)	Category
1	Fluency	60	Adequate
2	Flexibility	37	Low
3	Originality	48	Low
4	Elaboration	55	Adequate

Based on the table above, students can solve linear programming problems on indicators as much as 60% of students are able to write down what is known and asked in the questions given. The students who get a score of 4 can be seen in the following figure.

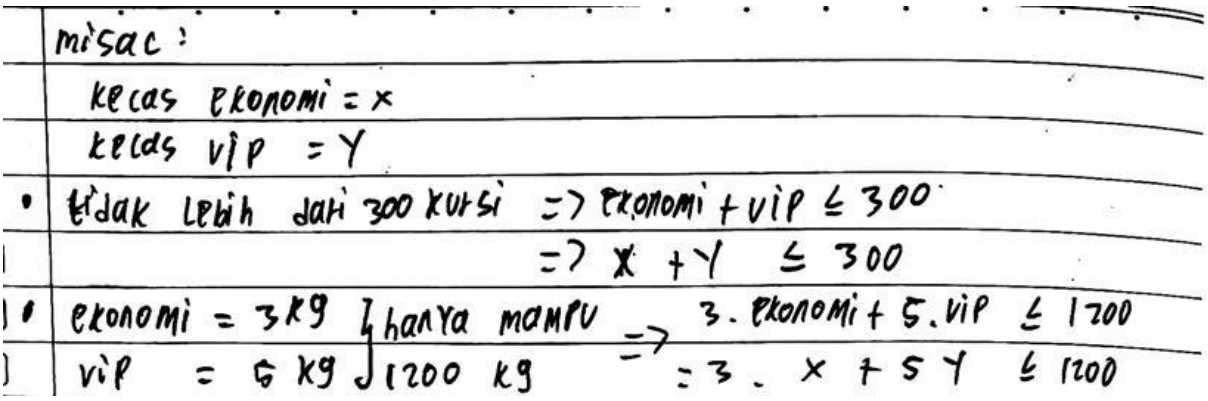

Figure 1. Students' Answers on The Fluency Aspect

In the indicator of flexibility, students, in this case, are students' abilities in expressing various solutions, as well as building various ideas from different points of view. The following are student answers on the flexibility indicator as shown in the following figure.

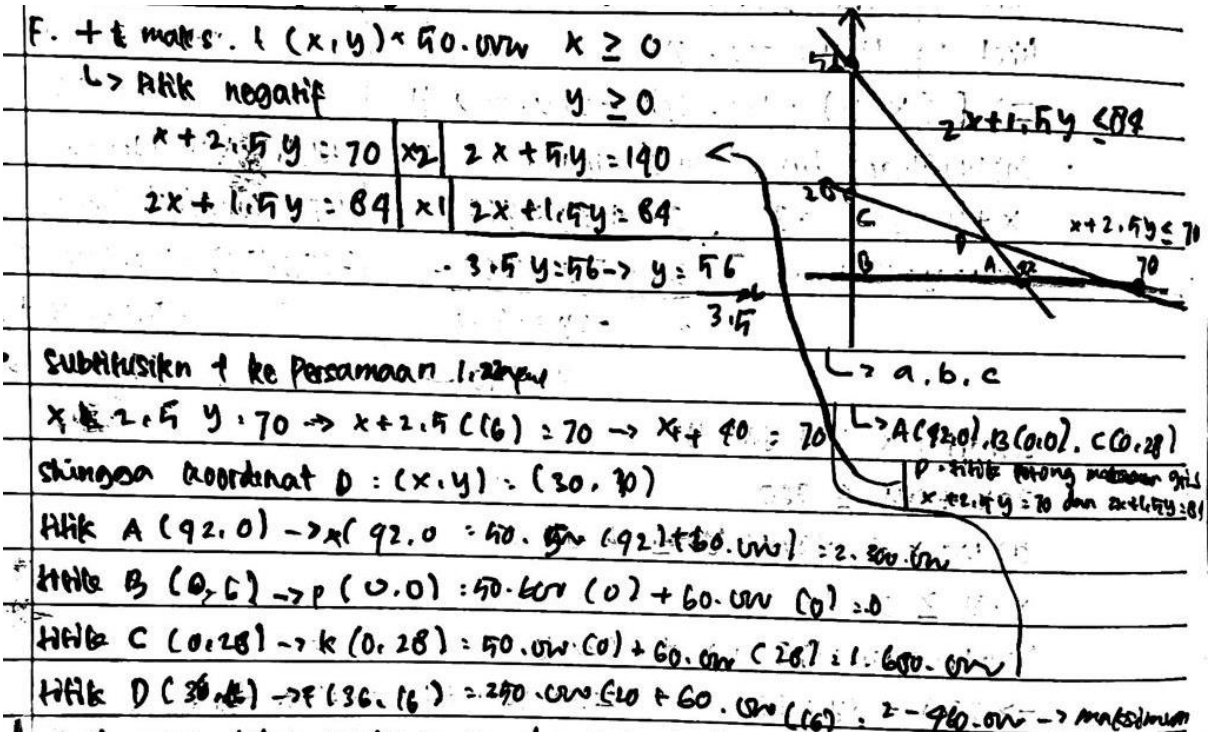

Figure 2. Students' Answers on The Flexibility Aspect

37% of students are able in the indicator of flexibility. the aspect of flexibility is still relatively low. This is in line with Laras Ismara (2016) which states that the ability to think creatively on open-ended questions on the flexible thinking aspect, students are included in the low category.

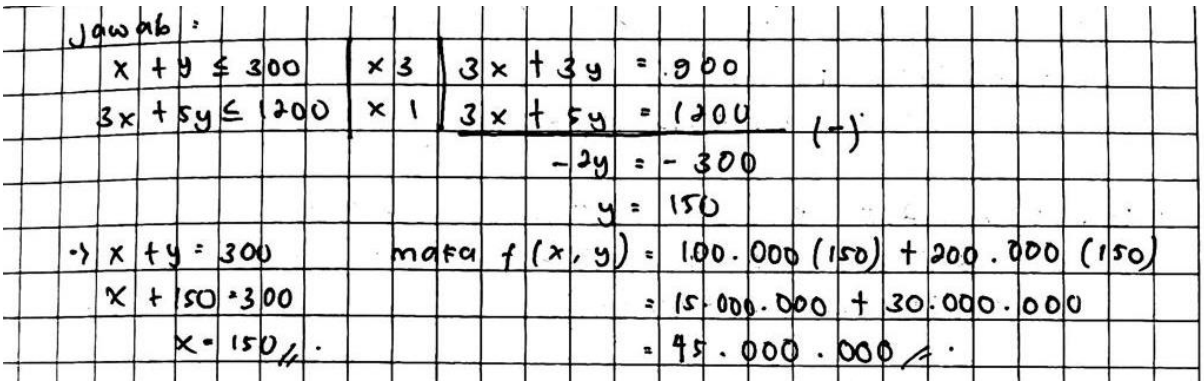

Figure 3. Students' Answers on The Originality Aspect

The results of data analysis showed 35% of students were able to work on the authenticity indicator. This is in line with Laras Ismara's research (2016) which found that creative thinking skills in the original thinking aspect were included in the very low category.

Thinking ability Elaboration (elaboration) of students in this case is the ability of students in detailing the answers made in detail. The criteria for the ability in question are that students can provide correct and detailed answers. The following are the answers of students who get a score of 4 in the elaboration aspect

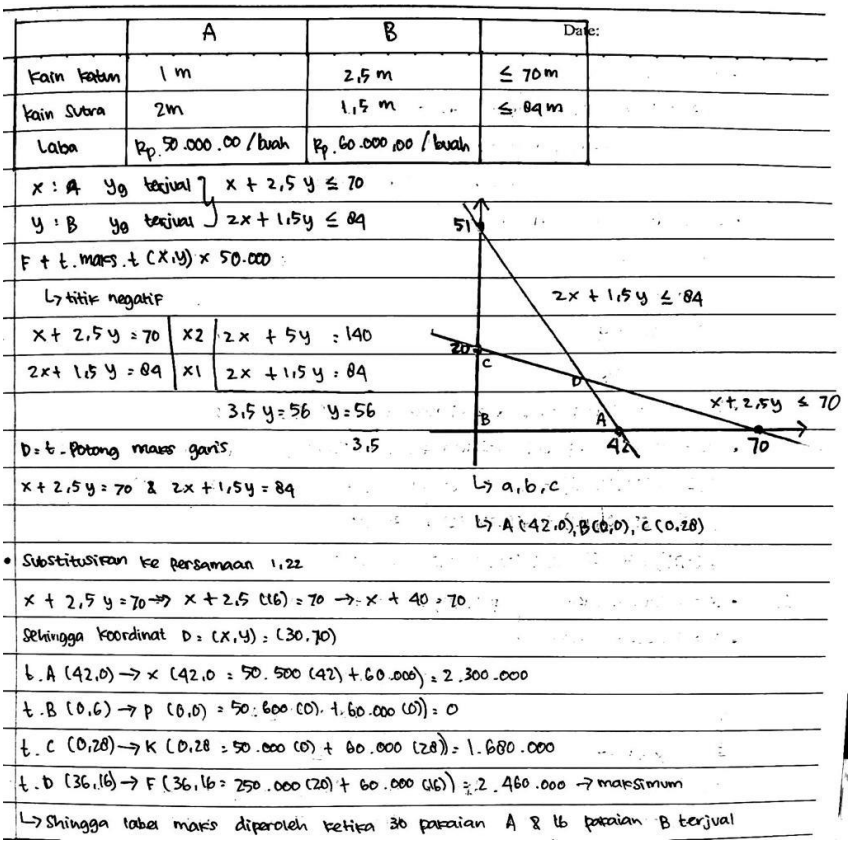

Figure 4. Students' Answers on The Elaboration Aspect

The results of data analysis showed as many as 55% of students were able to detail the answers they did. Abdul Salim (2017) found that the students' ability to detail was still lacking. Ika Mustika Sari (2013) also concluded that the students' ability to think creatively in the elaboration aspect has the smallest average percentage.

Siswono (2008) in his journal reveals that there are 5 levels of creative thinking ability. Starting from the highest level 4 to level 0 as the lowest. If students have aspects of fluency and flexibility, then these students have TKBK 3 (creative), whereas if students have aspects of fluency, flexibility and novelty, then these students have TKBK 4 (very creative). From the results of the analysis, on linear programming material, as many as 3 people are at the level of creative thinking ability level 4 (very creative), 5 people are at level 3 (creative), 10 people are at level 2 (less creative) and 13 people are at the ability to think. creative level 1 (less creative). This is in line with Yayah's research (2019); Adiastuty (2021); and Sari (2021) which states that only students with low mathematical abilities can achieve a low level of creativity.

CONCLUSION

Based on the results of research and discussion, it can be concluded that in linear programming material, 3 people were at the level of creative thinking ability level 4 (very creative), 5 people were at level 3 (creative), 10 people were at level 2 (less creative) and 13 people were at level 1 creative thinking ability (less creative).

REFERENCES

Adiastuty, N., Sumarni, Riyadi, M., Nisa, A., & Waluya. (2021). Neuroscience Study : Analysis of Mathematical Creative Thinking Ability Levels in Terms of Gender Differences in Vocational High School Students. *J.Phys.: Conf. Ser*, *1933*(012072), 1–7. https://doi.org/10.1088/17426596/1933/1/012072

Andiyana, M. A., Maya, R., & Hidayat, W. (2018). "Analisis kemampuan berpikir kreatif matematis siswa SMP pada materi bangun ruang". Journal Pebelajaran Matematika Inovatif, 1(3), 239–248. https://doi.org/10.22460/jpmi.v1i3.239-248

Bahar, A. K. & Maker, C. J. (2011). Exploring the Relationship Between Mathematical Creativity and Mathematical Achievement. *Asia-Pasific Journal of Gifted and Talented*

Education, Volume 3, Issue 1, 33-48.

Dilla, S. C., Hidayat, W., & Rohaeti, E. E. (2018). Faktor Gender dan Resiliensi dalam Pencapaian Kemampuan Berpikir Kreatif Matematis Siswa SMA. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*. https://doi.org/10.31331/medives.v2i1.553

Hendriana, H, Rohaeti, EE, & Sumarmo, U. (2018). *Hard Skill dan Soft Skills Matematik Siswa*. Refika Adimata.

Inayah, S., Septian, A., & Suwarman, R. F. (2020). Student Procedural Fluency in Numerical Method Subjects. *Desimal: Jurnal Matematika*, *3*(1), 53–64. https://doi.org/10.24042/djm.v3i1.5316

Ismara, L. (2017). Kemampuan Berpikir Kreatif Matematis Siswa Dalam Menyelesaikan Soal Open Ended Di SMP. *Jurnal Pendidikan dan Pembelajaran*, *6*(9).

Latifah, D., & Madio, S. S. (2014). Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Melalui Model Pembelajaran Missouri Mathematics Project (MMP). Mosharafa: Jurnal Pendidikan Matematika, 3(3), 159-168

Lestari, N., & Zanthy, L. S. (2019). Analisis Kemampuan Berpikir Kreatif Matematis Siswa SMK Di Kota Cimahi Pada Materi Geomertri Ruang. JPMI (Jurnal Pembelajaran Matematika Inovatif), 2(4), 187–196.

Maharani, H. R. (2017). Creative Thinking Process based on Wallas Model in Solving Mathematics Problem. *International Journal on Emerging Mathematics Education*, *1*(2), 177–184.

Mayasari, Y. (2016). Kemampuan Koneksi Matematis Siswa Melalui Model Pembelajaran Berbasis Masalah (Studi Penelitian di SMP Negeri 5 Garut). *Jurnal Riset Pendidikan*, *2*(01), 27-44.

Moma, L. (2016). Pengembangan Instrumen Kemampuan Berpikir Kreatif Matematis Untuk Siswa SMP. *Delta-Pi: Jurnal Matematika dan Pendidikan Matematika*, *4*(1).

Mulyaningsih, T., & Ratu, N. (2018). Analisis Kemampuan Berpikir Kreatif Siswa SMP dalam Memecahkan Masalah Matematika pada Materi Pola Barisan Bilangan. *Pendekar: Jurnal Pendidikan Berkarakter*, *1*(1), 34–41.

NCTM. (2000). *Principles and Standards for School Mathematics*. *The National Council of Teachers of Mathematics, Inc.* Reston, VA: The National Council of Teachers of Mathematics, Inc.

Rachman, A. F., & Amelia, R. (2020). Siswa SMA Di Kabupaten Bandung Barat Dalam Menyelesaikan Soal Pada Materi Trigonometri. *Maju*.

Restiana, N., & Pujiastuti, H. (2019). Pengukuran Technological Pedagogical Content Knowledge untuk Guru Matematika SMA di Daerah Tertinggal. *Mosharafa: Jurnal Pendidikan Matematika*, *8*(1), 83-94.

Rosmaiyadi, R. (2017). Analisis Kemampuan Berpikir Kritis Matematis Siswa Dalam Learning Cycle 7e Berdasarkan Gaya Belajar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*. https://doi.org/10.24127/ajpm.v6i1.722

Salim, A. (2017) Kemampuan Berpikir Kreatif Siswa dalam Penyelesaian Soal Open ended Materi Statistika pada Kelas IX SMP. *Jurnal Pendidikan dan Pembelajaran Untan*, *6*(7).

Sari, D. N., Sumarni, & Riyadi, M. (2019). Analisis kemampuan berpikir kreatif siswa dengan menggunakan soal open ended. in *Seminar Nasional Pendidikan Matematika 2018 Tema Peran Pendidikan Matematika dalam Menghadapi Revolusi Industri 4.0"* (pp. 150–164).

Septian, Ari & Rizkiandi, Riki. (2017). Penerapan Model *Problem Based Learning* (PBL) Terhadap Peningkatan Kemampuan Berpikir Kreatif Matematis Siswa. PRISMA, 1(1) https://doi.org/10.35194/jp.v6i1.22

Siswono, T. 2018. Pembelajaran matematika Berbasis Pengajuan dan Pemecahan Masalah. Pt Remaja Rosdakarya: Bandung.

Sugiyono. (2020). Metode Penelitian Kuantitatif, Kualitatif, da R&D. Bandung: CV Alfabeta.

Sulastri, S., & Haq, C. N. (2013). Perbedaan Kemampuan Komunikasi Matematik Siswa antara yang Mendapatkan Model Pembelajaran Jigsaw dan Cooperative Script. *Mosharafa: Jurnal Pendidikan Matematika*, *2*(2), 111-122.

Suriany, E. (2016). Peningkatan Kemampuan Berpikir Kreatif Matematis Siswa SMA melalui Pembelajaran Math-Talk Learning Community. *Indonesian Digital Journal of Mathematics and Education*.

Suryadi, A. (2015). Sistem Pengenalan Wajah Menggunakan Metode Principal Component Analysis (Pca) Dengan Algoritma Fuzzy C-Means (Fcm). *Mosharafa: Jurnal Pendidikan Matematika*, *4*(2), 58-65.

Suwarto, S. (2018). Analisis Kesulitan Belajar Operasi Hitung pada Siswa Kelas Satu Sekolah Dasar. *Mosharafa: Jurnal Pendidikan Matematika*, *7*(2), 285-294.

Wahyudi, Waluya, S. B., Rochmad, & Suyitno, H. (2018). Assimilation and Accommodation Processes in Improving Mathematical Creative Thinking with Scaffolding According to Learning Style. In *Journal of Physics: Conference Series* (Vol. 1097), Institute of Physics Publishing. https://doi.org/10.1088/1742-6596/1097/1/012156

Yayah, H., Elang, W., & Lensi, H. (2019). Analisis Kemampuan Berfikir Kreatif Matematis Siswa Dalam Menyelesaikan Soal Pemecahan Masalah. *Indonesian Journal Elementary Eduction*, *1*(1), 56–65.