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The Effectiveness of Augmented Reality-Assisted Scientific Approach to Improve Mathematical Creative Thinking Ability of Elementary School Students

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Abstract

This study aims to determine the effectiveness of the scientific approach assisted by augmented reality in improving students' mathematical creative thinking ability. This research is a quasi-experimental study with a pretest-posttest control group design. The participants in this study were 5th-grade students in 2 (two) integrated Islamic elementary schools in Cirebon City, Indonesia, with a total of 47 students. The data in this study were collected through a mathematical creative thinking ability test that refers to fluency, originality, flexibility, and elaboration indicators. Then the data that collected was analyzed through descriptive, n-gain test, and Mann Whitney tests. The results showed that there was a significant difference in the n-gain score of students' mathematical creative thinking skills between the experimental group using a scientific approach assisted by augmented reality and the control group using direct instruction learning assisted by augmented reality, where the U value was 129.5, the value was 129.5. Z of -3.380, and the value of Sig. (2-tailed) of 0.001 < 0.05. The mean score of n-gain and posttest score of mathematical creative thinking ability of experimental group students was significantly higher than that of the control class. So

the scientific approach assisted by augmented reality effectively improves students' mathematical creative thinking skills..

Keywords: *mathematical creative thinking, scientific approach, direct instruction, augmented reality.*

Abstrak

Penelitian ini bertujuan untuk menentukan efektifitas pendekatan saintifik berbantuan augmented reality dalam meningkatkan kemampuan berpikir kreatif matematis siswa. Penelitian ini merupakan penelitian kuasi-eksperimen dengan desain pretest-posttest control group desain. Partisipan dalam penelitian ini adalah siswa kelas 5 di 2 (dua) sekolah dasar Islam terpadu di Kota Cirebon, Indonesia yang berjumlah 47 siswa. Data dalam penelitian ini dikumpulkan melalui tes kemampuan berpikir kreatif matematis yang mengacu pada indikator kelancaran, keluwesan, fleksibilitas, dan elaborasi. Kemudian data yang telah dikumpulkan dianalisis melalui uji deskriptif, uji n-gain, dan uji mann whitney. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang signifikan dalam skor n-gain kemampuan berpikir kreatif matematis siswa antara kelompok eksperimen yang menggunakan pendekatan saintifik berbantuan augmented reality dengan kelompok kontrol yang menggunakan pembelajaran *direct instruction* berbantuan *augmented reality*, di mana nilai U sebesar 129,5, nilai Z sebesar -3,380, dan nilai Sig. (2-tailed) sebesar 0,001 < 0,05. Rerata skor n-gain dan skor posttest kemampuan berpikir kreatif matematis siswa kelompok eksperimen secara signifikan lebih tinggi dari pada kelas kontrol. Sehingga dapat disimpulkan bahwa pendekatan saintifik berbantuan augmented reality efektif meningkatkan kemampuan berpikir kreatif matematis siswa.

Kata kunci: *berpikir kreatif matematis, pendekatan saintifik, direct instruction, augmented reality.*

INTRODUCTION

Learning mathematics in Indonesia at the basic education level aims to develop student's abilities to think logically, analytically, systematically, critically, and creatively. This is in line with the National Council of Teachers of Mathematics (NCTM) (1989), which states that one of the goals of learning mathematics is to develop the ability to solve non-routine problems. Furthermore, NCTM (2000) states that the ability to solve non-routine problems (critical and creative thinking) is one of the most important components of mathematics. This is because developing critical and creative thinking skills is the main agenda in the world's mathematics education curriculum (Firdaus, Kailani, & Bakar, 2015); (Lunenburg, 2011).

Creative thinking, according to Isaksen, Dorval, & Treffinger (Parnes, 1992), is the ability to think that can produce various possible responses, ideas, or problem-solving alternatives. Meanwhile, according to Munandar (2002), the ability to think creatively is the ability to find many answers to a problem, where the emphasis is on the diversity of answers. The ability to think creatively mathematically can be measured using indicators of fluency, flexibility, and originality (Bosch, 1997; Fauziah, 2011; Gunawan, Suraya, & Tryanasari, 2014; Arisanti, Sopandi, & Widodo, 2016; Kattou, Christou, & Pitta-Pantazi, 2016).

Mann, Chamberlin, and Graefe (2016) explain that what fluency means is the ability to generate many ideas. Meanwhile, flexibility is the ability to respond differently to a question (Vidal, 2005). Originality is a mathematical response that must be original and rare and the mathematical problems that follow it (Lev & Leikin, 2017). Moreover, elaboration is expanding answers to problems and bringing up new ideas. Therefore, students must be given open- problem questions to see the number of students' ideas for solving math problems (Marzuki, Asih, & Wahyudin, 2109).

However, Indonesian students's mathematical creative thinking skills still need to be improved. Arifuddin (2019) research revealed that the ability to think creatively in Islamic primary school students in fractional material is still relatively low, with an average score of 26.88. Faelasofi (2017), in his research, revealed that students' creative thinking skills in opportunity material were also still low; namely, the average score was 59.26. Ismara, Halini, and Suratman (2017) revealed that students' creative thinking abilities on the flexibility and originality indicators were also still low, where the average scores were 1.59 and 0.82 respectively. Kulsum et al. (2019) also expressed the same thing average score of students' creative thinking abilities on the fluency and flexibility indicators was 2.27. On the originality and elaboration indicators the average scores were 0.81 and 1.54. The research results also reinforce this by Puspitasari, In'am, and Syaifuddin (2018), which revealed that students still experience difficulties understanding mathematical problems related to creative mathematical thinking. The strategy used in solving creative thinking questions is still trial and error, unstructured and systematic.

Based on the results of these studies, students' mathematical creative thinking skills must be improved. One effort that teachers can make to improve students' mathematical creative thinking skills is to apply a learning approach and learning media that are oriented towards mathematical creative thinking abilities. Because the use of appropriate learning approaches and learning media in learning mathematics can help students learn abstract mathematics (Widodo & Wahyudin, 2018). Furthermore, a scientific approach assisted by augmented reality is one of the learning approaches and learning media oriented toward thinking creatively and mathematically.

The scientific approach is learning that facilitates students to acquire knowledge and skills using scientific procedures/methods (Kemdikbud, 2013). Meanwhile, according to Hidayati & Retnawati (2016), a scientific approach is a learning approach that actively involves students in the thought process and the use of the scientific method by conducting experiments to test hypotheses, encouraging and inspiring students to think critically and think hypothetically in seeing differences. Similarities and interrelationships with each other in the research substance. According to Dyer, Gregersen, and Christensen (2019), the scientific approach steps are first, associating activities; second, questioning activities. And third, observing activities; fourth, networking activities, and fifth, experimenting activities.

Furthermore, augmented reality is a technological innovation in learning (Wang, Callaghan, Bernhardt, White, & Peña-Rios, 2018). This augmented reality technology transfers virtual objects to the real world (Akçayır & Akçayır, 2017). Zhou, Duh, & Billinghurst (2008) emphasized that augmented reality is a technology that allows computer-generated virtual objects to be placed on physical objects in real-time. The advantage of using augmented reality is that it makes learning more interactive and interesting so that it

can increase student learning achievement (Akçayır & Akçayır, 2017). Augmented reality also has characteristics that need to be displayed, including that augmented reality combines real information and virtual information, interactive augmented reality in real-time, and augmented reality operates and uses a 3D environment (Kipper & Rampola, 2013).

Several researchers have conducted previous research on increasing the ability to think creatively. Jawad, Majeed, and Al Rikabi (2021) researched the use of the STEM approach to improve the creative thinking abilities of grade 4 students. Their research showed that using the STEM approach in the learning process increased creative thinking skills and student learning motivation. Lopes et al. (2019) examined the effectiveness of the cooperative learning model in increasing students' mathematical creative thinking abilities. Maskur et al. (2020) examined the effect of Problem Based Learning and Aptitude Treatment Interaction on the ability to think creatively mathematically. The results of his research show that the Aptitude Treatment Interaction learning model has more influence on students' mathematical creative thinking abilities. Ratnaningsih (2017); Putri and Hasbi (2018); Siviani, Zubainur, and Subianto (2018); Kurniati and Sutiarso (2021). Researched the implementation of problem-based learning in improving students' creative thinking abilities. The results of his research show that the implementation of problem-based learning is effective in increasing students' mathematical creative thinking abilities. Suastika (2017); Rahma, Novtiar, and Sugandi (2018) researched using open-ended to improve students' creative thinking skills. The results of his research show that the open-ended learning model can improve students' mathematical creative thinking abilities. Sariningsih and Kadarisma (2016) examined an ethnomathematics-based scientific approach. The results of his research show that an ethnomathematics-based scientific approach can improve students' mathematical creative thinking abilities.

In contrast to previous research, this research focuses on increasing students' mathematical creative thinking abilities through a scientific approach assisted by augmented reality. Expected that the application of a scientific approach assisted by augmented reality can improve the mathematical creative thinking abilities of elementary school students. This study aims to determine the effectiveness of the scientific approach assisted by augmented reality in improving students' mathematical creative thinking abilities.

METHODS

This research is quasi-experimental with a control group pre-test and post-test design. This design involved students divided into experimental and control groups, each given a different treatment. The experimental group is the group that uses a scientific approach assisted by augmented reality. Meanwhile, the control group used direct instruction with the help of augmented reality. The pretest and post-test were used for each group to see an increase in students' mathematical creative thinking abilities in both groups.

The initial step in this study was the researcher conducted a pretest, both in the experimental and control groups, to determine students' initial mathematical creative thinking abilities in both groups. Data from this pretest were analyzed first using the prerequisite statistical test before testing the level of balance using the t-test. If declared normal and homogeneous, the two sample groups were given treatment as planned, the experimental group was treated using a scientific approach assisted by augmented reality,

and the control group was treated using direct instruction assisted by augmented reality. Then a posttest was carried out to obtain data related to the scores of students' mathematical creative thinking abilities. The posttest data were also subjected to prerequisite statistical analysis beforehand to determine what hypothesis test would be used, whether a parametric test or non-parametric test, to see the average difference in students' mathematical creative thinking abilities from the two sample groups.

This research was conducted in 2 (two) integrated Islamic elementary schools in Cirebon City, Indonesia, with the chosen sample being the fifth grade in each school. The school was chosen because it has the same characteristics: an integrated Islamic elementary school. The sampling technique in this study was purposive, namely, a sampling technique with certain considerations. The experimental group consisted of 27 students, while the control group consisted of 22 students.

The data collection techniques in this study were tests and documentation. Mathematical creative thinking ability tests are applied at the pretest and posttest. The questions in the test cover material related to the volume of blocks and cubes. The test consists of three description questions related to the volume of cubes and blocks. The questions were tested for validity and reliability using SPSS software and met valid and reliable criteria. Meanwhile, documentation techniques are used to collect the data needed during the research process. To see students' mathematical creative thinking abilities based on pretest and posttest results, researchers used an assessment rubric based on aspects of students' mathematical creative thinking developed by Bosch (1997) with indicators of fluency, flexibility, originality, and elaboration.

The research data were then analyzed using descriptive analysis and the Mann Whitney test. Prior to the Mann Whitney test, a prerequisite test was carried out on the pretest and posttest scores, which included the normality test and homogeneity test. This is done to see whether the pretest and posttest scores are normally distributed or not and whether the population has the same variance or not. All test scores were analyzed using SPSS software version 22.

RESULTS AND DISCUSSION

Descriptive Statistic Result

The first phase of the data analysis process was conducted using descriptive analysis to draw the data collected from the pre-test and post-test of the Students' Mathematical Creative Thinking Ability. Hence, the descriptive statistic result of the pre-test and post-test of Students' Mathematical Creative Thinking Ability (SMCTA) is presented in Table 1.

Table 1. Descriptive Statistic of Pre and Post-test
Students Mathematical Creative Thinking Ability

Group	Statistic	Score		N
		Pretest	Posttest	
AR assisted Scientific Approach	Mean	36.44	76.67	27
	Std. Deviation	10.330	13.703	
	Minimum	17	34	
	Maximum	59	100	

AR assisted	Mean	35.15	64.64	22
Direct Instruction	Std. Deviation	10.871	15.370	
	Minimum	17	34	
	Maximum	59	84	

Table 1 shows that the pretest average scores of students' mathematical creative thinking skills in the control group (AR assisted Direct Instruction) and the experimental group (AR assisted Scientific Approach) tend to be the same, namely 35.15 and 36.44 with a standard deviation of 10,330 and 10,871. Meanwhile, the posttest average scores for students' mathematical creative thinking abilities in the control group (AR assisted Direct Instruction) and the experimental group (AR assisted Scientific Approach) were 64.64 and 76.67, respectively, with a standard deviation of 15,370 and 13,703.

Furthermore, to determine the difference in effectiveness between the scientific approach assisted by Augmented Reality and direct instruction-assisted learning by augmented reality in improving students' mathematical creative thinking abilities, an n-gain test was carried out. The results of the n-gain test between the experimental and control group are presented in table 2 below.

Table 2. Descriptive statistic of N-gain Score of Students' Mathematical Creative Thinking Ability

Group	**Statistic**	**N-Gain Score SMCTA**	**N**
AR assisted	Mean	65,31	27
Scientific Approach	Std. Deviation	17,148	
	Minimum	20	
	Maximum	100	
AR assisted	Mean	47,01	22
Direct Instruction	Std. Deviation	16,489	
	Minimum	12	
	Maximum	68	

Table 2 above shows that the n-gain score of students' mathematical creative thinking abilities in the experimental group (AR-assisted Scientific Approach) has the lowest score of 20 and the highest score of 100, with an average score of 65.31 and a standard deviation of 17.148. Meanwhile, the n-gain score of students' mathematical creative thinking abilities in the control group (AR-assisted direct instruction) had the lowest score of 12 and the highest score of 68, with an average score of 47.01 and a standard deviation of 16,489.

Normality and Homogeneity Test

Normality and homogeneity tests are carried out as prerequisite tests to determine what hypothesis test to use and whether parametric hypothesis testing or non-parametric hypothesis testing. The results of the normality test score Gain students' mathematical creative thinking abilities between the experimental and control groups, as shown in Table 3.

Table 3. Normality Test of Gain Score of Students Mathematical Creative Thinking

Variable	Learning Model	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Mathematical Creative Thinking	AR assisted scientific approach	.108	27	.200*
	AR assisted Direct Instruction	.205	22	.017

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 3 above, shows that in the Kolmogorov-Smirnov column for the experimental group (AR-assisted scientific approach) the significance value is 0.20 or equal to 20%. Because the significance value is more than 5%, it can be concluded that the n-gain scores for students' mathematical creative thinking abilities in the experimental class are normally distributed. Furthermore, in the Kolmogorov-Smirnov column for the control group (AR-assisted direct instruction), the significance value is 0.017 or equal to 1.7%. Because the significance value is less than 5%, it can be concluded that the n-gain scores for the mathematical creative thinking abilities of the control class students are not normally distributed.

After the prerequisite test is carried out through the normality test, a homogeneity test is carried out to determine whether the data is homogeneous or heterogeneous. The results of the homogeneity test are presented in table 4 below.

Tabel 4. Test of Homogeneity of Variances
Posttest_score

Variable	Levene Statistic	df1	df2	Sig.
Students' Mathematical Creative Thinking	.237	1	47	.629

Table 4 above shows that Sig 's, significance value is 0.629 > 0.05. Because the significance value is greater than 0.05, it can be concluded that the n-gain score of students' mathematical creative thinking ability is homogeneous. Although the results of the homogeneity test showed that the n-gain scores of students' mathematical creative thinking abilities were homogeneous, based on the results of the data normality test, the n-gain scores of students' mathematical creative thinking abilities were not normally distributed. So that the data hypothesis test was carried out through non-parametric hypothesis testing using the Mann-Whitney test.

Mann-Whitney Test

The Mann-Whitney test was performed to test the hypothesis. The results of the Mann-Whitney hypothesis test are presented in table 5.

Table 5. The Result of Mann-Whitney Test

Test Statistics[a]

	gain_score
Mann-Whitney U	129.500
Wilcoxon W	382.500
Z	-3.380
Asymp. Sig. (2-tailed)	.001

a. Grouping Variable: Learning Model

Based on table 5 above, it can be seen that the U value is 129.5 and the W value is 382.5. When converted to a Z value, the magnitude is -3.380. Meanwhile, the value of Sig. (2-tailed) of 0.001 <0.05. This means a significant difference in the test scores of students' mathematical creative thinking skills between the experimental group that uses an augmented reality-assisted scientific approach and the control class that uses augmented reality-assisted direct instruction learning. So the use of augmented reality-assisted scientific approaches is more effective than augmented reality-assisted direct instruction learning in improving students' mathematical creative thinking abilities.

Based on the research results described above, the augmented-assisted scientific approach is more effective in improving elementary school students' mathematical creative thinking skills. This is because the use of a scientific approach in the learning process can involve students actively in the thinking process by conducting experiments to test hypotheses, encouraging and inspiring students to think critically and think hypothetically in seeing differences, similarities, and interrelationships with each other in research substance.

In addition, the use of Augmented Reality media also plays an important role in realizing and visualizing abstract concepts according to student's level of understanding . It allows observation of phenomena that are impossible to encounter in real life (Sahin & Yilmaz, 2020). Augmented reality can digitally take information generated by a computer, be it in images, sound, video, and touch or haptic sensations, and overlay it with an environment in the real world. Therefore, augmented reality supplements reality rather than completely replacing it with a virtual environment (Komansilan, 2012). Augmented reality also has characteristics that need to be displayed, including that augmented reality combines real information and virtual information, interactive augmented reality in real-time and augmented reality operates and uses a 3D environment (Kipper & Rampola, 2013).

Augmented reality has many advantages, one of which is that augmented reality can increase student engagement in classso that students can exploreexploring relationships between mathematical concepts (Cai, Liu, Shen, Liu, Li, & Shen, 2020). Augmented Reality applications can also increase students' enthusiasm and interest during the mathematics learning process; helping students to concretize abstract concepts; Augmented Reality requires less time and than traditional methods (Ibili, Resnyansky, & Billinghurst, 2019). The application of augmented reality in the learning process can also reduce math anxiety and low student learning motivation (Chen, 2019). According to him, augmented reality can provide users with an interesting visual experience and visualize abstract concepts.

These research results are also reinforced by Karmiatun & Odja (2019); Istiqomah, Perbowo & Purwanto (2018); Hidayati & Retnawati (2016), who revealed that the use of a scientific approach could improve creative thinking skills and higher order thinking.

Meanwhile, Akçayır & Akçayır (2017); Altinpulluk (2019); Kazanidis & Pellas (2019); Buchori, Setyosari, Dasna, Ulfa, Degeng, & Sa'dijah (2017); Chang & Hwang (2018) also revealed that the use of augmented reality media also makes learning more interactive and interestingso that it can improve student attitudes, motivation, and achievement. In addition, Herrera, Perez & Ordonez's (2019) research also revealed that augmented reality could improve students' spatial abilities.

CONCLUSIONS

Based on the description of the research results, the scientific approach assisted by augmented reality is more effective than direct instruction assisted by augmented reality in improving students' mathematical creative thinking abilities. This can be seen from the results of the Mann-Whitney test that there is a significant difference between the experimental group using an augmented reality-assisted scientific approach and the control group using augmented reality-assisted direct instruction learning. Therefore, an augmented reality-assisted scientific approach can be an alternative learning method for teaching geometric materials in elementary schools.

REFERENCES

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20*, 1-11.

Altinpulluk, H. (2019). Determining the trends of using augmented reality in education between 2006-2016. *Education and Information Technologies, 24*(2), 1089-1114.

Arifuddin, A. (2019). Students' Critical and Creative Thinking Skills on Mathematics Learning in Madrasah Ibtidaiyah. *Auladuna: Jurnal Pendidikan Dasar Islam, 6*(1), 38-49.

Arisanti, W. O. L., Sopandi, W., & Widodo, A. (2016). Analisis Penguasaan Konsep dan Ketrampilan Berpikir Kreatif Siswa SD melalui Project Based Learning. *Eduhumaniora: Jurnal Pendidikan Dasar, 8*(1), 82–95.

Bosch, N. (1997). Rubric for Creative Thinking Skills Evaluation.

Botty, H. M. R. H., Masitha, S., Jainatul, H.J., Hui-Chuan, Li., & Maureen, S.F.C. (2016). The implementation of problem-based learning (PBL) in a year 9 mathematics classroom: a study in Brunei Darussalam. *International Research in Education, 4*(2), 34–47

Buchori, A., Setyosari, P., Dasna, I. W., Ulfa, S., Degeng, I. N. S., Sa'dijah, C., & Karangtempel, S. T. (2017). Effectiveness of Direct Instruction Learning Strategy Assisted by Mobile Augmented Reality and Achievement Motivation on Students Cognitive Learning Results. *Asian Social Science, 13*(9), 137-144.

Cai, S., Liu, E., Shen, Y., Liu, C., Li, S., & Shen, Y. (2020). Probability learning in mathematics using augmented reality: impact on student's learning gains and attitudes. *Interactive Learning Environments*, *28*(5), 560-573.

Chang, S. C., & Hwang, G. J. (2018). Impacts of an augmented reality-based flipped learning guiding approach on students' scientific project performance and perceptions. *Computers & Education, 125*, 226-239.

Dyer, J., Gregersen, H., & Christensen, C. M. (2019). *Innovator's DNA, Updated, with a New Preface: Mastering the Five Skills of Disruptive Innovators*. Harvard Business Press.

Faelasofi, R. (2017). Identifikasi kemampuan berpikir kreatif matematika pokok bahasan peluang. *JURNAL e-DuMath*, *3*(2).

Fauziah, Y. N. (2011). Analisis Kemampuan Guru dalam Mengembangkan Kemampuan Berpikir Kreatif Siswa Sekolah Dasar Kelas V pada Pembelajaran Ilmu Pengetahuan Alam. *Jurnal Penelitian Pendidikan, Edisi Khusus* (2), 98–106

Firdaus, F., Kailani, I., & Bakar, M. N. Bin. (2015). Developing Critical Thinking Skills of Students in Mathematics Learning. *Journal of Education and Learning*, *9*(3), 226–236.

Gunawan, I., Suraya, S. N., & Tryanasari, D. (2014). Hubungan Kemampuan Berpikir Kreatif dan Kritis dengan Prestasi Belajar Mahasiswa pada Matakuliah Konsep Sains II Prodi PGSD IKIP PGRI Madiun. *Premiere Educandum*, *4*(1), 10–40.

Herrera, L. M., Pérez, J. C., & Ordóñez, S. J. (2019). Developing spatial mathematical skills through 3D tools: augmented reality, virtual environments and 3D printing. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *13*(4), 1385-1399.

Hidayati, A. U., & Ratnawati, H. (2016). Effectiveness Problem Based Learning and Scientific Approach to Improve Higher Order Thinking Skills. *In Proceeding of 3rd International Conference on Research, Implementation And Education Of Mathematics And Science (pp. 55-60).*

Ibili, E., Resnyansky, D., & Billinghurst, M. (2019). Applying the technology acceptance model to understand maths teachers' perceptions towards an augmented reality tutoring system. *Education and Information Technologies*, *24*(5), 2653-2675.

Ismara, L, Halini, & Suratman, D. (2017). Kemampuan berpikir kreatif matematis siswa dalam menyelesaikan soal open ended di SMP. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa*, *6*(9).

Istiqomah, A., Perbowo, K. S., & Purwanto, S. E. (2018, January). Promoting middle school students' mathematical creative thinking ability using scientific approach. In *Journal of Physics: Conference Series (Vol. 948, No. 1, p. 012032).* IOP Publishing.

Jawad, L. F., Majeed, B. H., & ALRikabi, H. T. (2021). The Impact of Teaching by Using STEM Approach in The Development of Creative Thinking and Mathematical Achievement Among the Students of The Fourth Scientific Class. *International Journal of Interactive Mobile Technologies*, *15*(13).

Karmiatun, D., & Odja, A. H. (2019). The Effectiveness of Integrated Natural Science Learning by Using Scientific Approach-Based Module to Improve Students' Creative Thinking Skill. *International Journal of Active Learning*, *4*(2), 126-132.

Kattou, M., Christou, C., & Pitta-Pantazi, D. (2016). *Characteristics of the creative person in mathematics*. New York: Nova Science Publishers.

Kazanidis, I., & Pellas, N. (2019). Developing and Assessing Augmented Reality Applications for Mathematics with Trainee Instructional Media Designers: An Exploratory Study on User Experience. *Journal of Universal Computer Science, 25*(5), 489-514.

Kemdikbud. (2013). *Materi Pelatihan Guru Implementasi Kurikulum 2013*. Jakarta: Kemdikbud RI

Kipper & Rampolla. (2013). *Augmented Reality an Emerging Technologies Guide to AR. First Edition*. USA: Elsevier.Inc

Komansilan (2012). Augmented Reality dan Penggunaannya sebagai Media Pembelajaran. *Payangka: Jurnal Penelitian MIPA dan Pengajaranya, 6*(3), 57-62atic review of the literature. *Educational Research Review, 20*, 1-11.

Kulsum, S. I., Wijaya, T. T., Hidayat, W., & Kumala, J. (2019). Analysis on high school students' mathematical creative thinking skills on the topic of sets. *Jurnal Cendekia: Jurnal Pendidikan Matematika, 3*(2), 431-436.

Kurniati, N., & Sutiarso, S. (2021). The Effect of Problem Based Learning and Open-Ended Learning on Mathematics Creative Thinking Ability: A Meta Analysis Study. *Jurnal Pendidikan MIPA*, *22*(1), 112-120.

Lev, M., & Leikin, R. (2017). The interplay between excellence in school mathematics and general giftedness: Focusing on mathematical creativity. *Creativity and Giftedness*, 225–238.

Lopes, J., Silva, H., Catarino, P., Morais, E., & Vasco, P. (2019). Cooperative learning on promoting creative thinking and mathematical creativity in higher education. *REICE. Revista Iberoamericana Sobre Calidad, Eficacia y Cambio En Educacion*, *17*(3), 5-22.

Lunenburg, F. C. (2011). Critical Thinking and Constructivism Techniques for Improving Student Achievement. *National Forum of Teacher Education*, *21*(3), 1–9.

Mann, E. L., Chamberlin, S. A., & Graefe, A. K. (2016). *The Prominence of Affect in Creativity : Expanding the Conception of Creativity in Mathematical Problem Solving*. Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-38840-3

Marzuki, Asih, E. C. M, & Wahyudin. (2019, October). Creative thinking ability based on learning styles reviewed from mathematical communication skills. In *Journal of Physics: Conference Series* (Vol. 1315, No. 1, p. 012066). IOP Publishing.

Maskur, R., Rahmawati, Y., Pradana, K., Syazali, M., Septian, A., & Kinarya Palupi, E. (2020). The Effectiveness of Problem Based Learning and Aptitude Treatment Interaction in Improving Mathematical Creative Thinking Skills on Curriculum 2013. *European Journal of Educational Research*, *9*(1), 375-383.

Munandar, U. (2002). *Kreativitas & Keberbakatan; Strategi Mewujudkan potensi kreatif & Bakat*. Jakarta: PT Gramedia Pustaka Utama

National Council of Teachers of Mathematics (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA. Author

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston VA.

Parnes, S.J. (1992). *Source Book for Creative Problem Solving*. Buffalo, New York: Creative Education Foundation Press.

Puspitasari, L., In'am, A., & Syaifuddin, M. (2018). Analysis of students' creative thinking in solving arithmetic problems. *International Electronic Journal of Mathematics Education*, *14*(1), 49-60.

Putri, F., & Hasbi, M. (2018). Kemampuan Berpikir Kreatif Matematis Siswa Melalui Problem Based Learning. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *7*(1), 56-64.

Rahma, A. F., Novtiar, C., & Sugandi, A. I. (2018). Meningkatkan Kemampuan Berpikir Kreatif Matematis Siswa Kelas VIII MTs Negeri Sukasari Cimahi pada Materi Sistem Persamaan Linear Dua Variabel Menggunakan Pendekatan Open-Ended. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(2), 139-144.

Ratnaningsih, N. (2017). The analysis of mathematical creative thinking skills and self-efficacy og high students built through implementation of problem-based learning and discovery learning. *JPMI (Jurnal Pendidik. Mat. Indones., 2017, doi: 10.26737/jpmi. v2i2. 219*.

Sahin, D., & Yilmaz, R. M. (2020). The effect of Augmented Reality Technology on middle school students' achievements and attitudes towards science education. *Computers & Education*, *144*, 103710.

Sariningsih, R., & Kadarisma, G. (2016). Improving mathematical creative thinking ability and independence of junior high school student learning through scientific approaches based on ethnomatatics. *P2M STKIP Siliwangi*, *3*(1), 53-63.

Siviani, R., Zubainur, C. M., & Subianto, M. (2018). Kemampuan Berpikir Kreatif Siswa SMP melalui Model Problem Based Learning. *Jurnal Didaktik Matematika*, *5*(1), 27-39.

Suastika, K. (2017). Mathematics Learning Model of Open Problem Solving to Develop Students' Creativity. International Electronic Journal of Mathematics Education, 12(3), 569–577.

Vidal, R. V. V. (2005). Creativity for Operational Researchers. *Investigacao Operacional*, *25*, 1–24.

Wang, M., Callaghan, V., Bernhardt, J., White, K., & Peña-Rios, A. (2018). Augmented reality in education and training: pedagogical approaches and illustrative case studies. *Journal of ambient intelligence and humanized computing, 9*(5), 1391-1402.

Widodo, S. A., & Wahyudin, W. (2018). Selection of Learning Media Mathematics for Junior School Students. *TOJET: The Turkish Online Journal of Educational Technology*, *17*(1), 154–160.

Zhou, F., Duh, HBL, & Billinghurst, M. (2008). Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. In *Proceedings of the 7th IEEE/ACM International Symposium on Mixed and Augmented Reality* (pp. 193-202). IEEE Computer Society.