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Analysis of Mathematics Creative Thinking Ability in Each Gregorc Mind Styles with a Project-Based E-Learning Model

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Abstract

The difference in mind styles is one of the challenges to improving students' mathematical creative thinking ability—learning activities with a project-based e-learning model as an alternative to solve problems. The research aims to describe mathematical creative thinking ability in Gregorc mind styles with a project-based e-learning model. Gregorc mind style consists of concrete sequential (CS), abstract sequential (AS), concrete random (CR), and abstract random (AR). The mixed research method begins with quantitative research and then continues qualitatively. This research was conducted on vector material for class X high school students. The sampling technique is a probabilistic stratified sampling type where samples are taken in each Gregorc mind style with proportions according to their presence in the population. Students with CS mind styles dominated the results of the study. At the same time, students with AS mind styles were not found. The ANOVA test showed a significance value of 0,952 > 0,05, so there was no difference in mathematical creative thinking abilities in Gregorc's mind styles. However, every student with different mind styles has different achievement aspects of mathematical creative thinking ability. Therefore, three subjects were taken using each Gregorc mind style in the qualitative research stage. Students with the CS mind style can achieve the elaboration aspect well, but the originality aspect cannot be completed well. On the other hand, the originality aspect can be achieved very well by students with an AR mind style.

Keywords: Gregorc mind styles, mathematical creative thinking, project-based e-learning

Introduction

As one of the fields of study taught in schools, mathematics is expected to develop students' creative thinking abilities. Mathematical creative thinking is a high-level thinking ability, so mathematics learning in schools needs to emphasize the development of creative thinking abilities (Yayuk et al., 2020). Therefore, schools as formal educational institutions must provide opportunities for students to think creatively and actively, so creative thinking skills must be part of the school curriculum. Young et al. (2008) stated that it is not easy to teach students to think creatively in mathematics learning, so it is necessary to combine creative thinking in specially designed curriculum materials to support teachers and increase student involvement. Creativity is attracting increasing interest in mathematics education (Bicer & Bicer, 2023, Shwartz et al., 2025). In line with Leikin & Pitta-Pantazi (2013), Leikin & Sriraman, (2017) stated that creativity-based learning strategies in mathematics education have been defined widely. Students must have mathematical creative thinking abilities because this ability faces challenges in the Industrial Era 4.0 (Kardoyo et al., 2020). The Industrial Revolution 4.0 encourages students to innovate in the face of technological advances through creative thinking to solve problems.

Creative thinking refers to the ability to generate new ideas or solutions in the problem solving process (Hadar & Tirosh, 2019). Meanwhile, according to Bolden et al. (2010), mathematical creative thinking ability is based on applying knowledge to offer new insights into mathematical problems. Students with mathematical creative thinking abilities are not expected to produce extraordinary creative work but can provide new insights in solving mathematical problems. Students must have mathematical creative thinking ability not only to solve routine math problems but also to solve non-routine math problems with unique solutions and various possible problem-solving strategies. Mathematical creative thinking ability is measured through several aspects. Nadjafikhah & Yaftian, (2013), Ayllon et al. (2016), and Munahefi et al. (2020) stated that aspects of mathematical creative thinking ability consist of fluency, flexibility, elaboration, and originality. Fluency, namely, students can name various solutions to a problem correctly. Flexibility, namely, students can solve a problem by using several strategies. Elaboration, namely, students can solve complex problems in detail and coherently. Originals, namely, students can find unique and appropriate solutions to a problem.

The study's results by Aini et al., (2020) showed that each student has a different level of creative thinking. Bicer & Bicer (2023) also stated differences in the process of mathematical creative thinking in individuals. Differences in creative thinking abilities are caused by differences in achieving certain aspects of mathematical creative thinking (Yaniawati et al., 2020). One of the factors that causes differences in the achievement of aspects of mathematical creative thinking is differences in processing and organizing information. Differences in (Ul Ansar, M.R., & M.P. Ganesh, 2016) processing and organizing information lead to different mind styles . Alkathiri et al. (2018) stated that there is a relationship between mind style and mathematical creative thinking ability. Mind style is a person's tendency to organize and process information to solve problems. People with different mind styles tend to differ in their mathematical creative thinking abilities.

Bicer & Bicer (2023), Puspitasari et al. (2018), Nuha et al. (2018) conducted research related to mathematical creative thinking processes. Hobri et al. (2018) also researched the level of mathematical creative thinking. Many research have also been done on instruments for measuring mathematical creative thinking ability. However, only a few studies have been conducted regarding analyzing the achievement of aspects of mathematical creative thinking in each mind style. Therefore, the research intends to analyze the achievement of students' mathematical creative thinking aspects in each Gregorc mind style. Gregorc mind style consists of Concrete Sequential (CS), Concrete Random (CR), Abstract Sequential (AS), and Abstract Random (AR). Someone with a CS mind style tends to be precise, specific, and consistent. The characteristics of people with the CR mind style are that they are objective, thorough, logical, and systematic. Individuals with an AS mind style are sensitive, imaginative, spontaneous, and flexible. Meanwhile, individuals with AR mind styles have intuitive, realistic, and innovative characteristics.

Each student has a mind style that can be identified and developed so that students become more successful in their studies. Teachers are expected to design learning strategies and methods that suit the characteristics of students after understanding the differences in thinking styles in learning, especially in learning mathematics so that students can think logically, analytically, systematically, critically and creatively. Learning innovation is needed to overcome the various characteristics of students in each mind style. Students are expected to

have mathematical creative thinking even though they have different thinking styles through appropriate learning models. Training could increase creativity (Scott et al., 2004).

The project-based e-learning model as an innovation in mathematics learning is expected to improve mathematical creative thinking abilities. Ummah et al. (2019) stated that project-based learning could develop student creativity. Ralph (2016) encourages students to construct ideas to generate various unique ideas actively. Students in this model must independently develop projects based on the instructions. Therefore, the project-based e-learning model encourages students to explore their abilities to create new and diverse ideas. Mota et al., (2024) stated that project-based learning is a learning model that uses problems as a first step in collecting and integrating new knowledge based on their experiences in actual activities. According to Zhang & Ma, (2023), project-based learning is learning that uses projects as a medium in the learning process to achieve attitudes, knowledge, and skills competencies. Through this project-based e-learning, students will practice planning, carry out activities as planned, and display or report the results of activities through project learning.

Mathematics learning has developed along with technological developments. The positive consequence of these changes is a flexible learning process. Learning activities at this time can be done anytime and anywhere through e-learning. Therefore, the project-based e-learning model supports the implementation of distance learning. The project-based e-learning model utilizes electronic media in the learning process. According to Kristanto et al., (2017), E-learning is sending learning materials using electronic media so that learning activities can be carried out flexibly. Through the project-based e-learning model, teachers can easily monitor all students' learning processes so that teachers can quickly identify students' strengths and weaknesses when learning. Based on these problems, the research applied a project-based e-learning model to develop mathematical creative thinking for each Gregorc mind style so that researchers could identify the achievements of aspects of students' mathematical creative thinking ability for each Gregorc mind style. The study aims to analyze the differences in creative thinking abilities of each Gregorc thinking style with a project-based e-learning model.

Methods

The research method used in this study is a mixed method with a sequential explanatory design. The Sequential Explanatory design begins with quantitative research methods and continues with qualitative methods. Combining quantitative and qualitative methods provides a better understanding of problems and research questions than if they were carried out separately. A quantitative method for measuring differences in students' mathematical creative thinking ability scores in each Gregorc mind style through a project-based e-learning model. A qualitative method was used to analyze aspects of mathematics creative thinking ability achieved in each of Gregorc's mind styles.

The population of this study was students at the senior high school level, class X, at SMA Negeri 3 Klaten. The sampling technique used in this study was a probabilistic sampling of the stratified sampling type. The researchers divided the population based on unique characteristics, namely the Gregorc thinking model. All students of class X identified Gregorc's mind style, and then a sample was taken for each Gregorc's mind style, with the proportions according to their presence in the population. The technique of selecting research subjects for

collecting qualitative data is purposive sampling. In purposive sampling, the researcher selects individuals deliberately to study and understand the central phenomenon. They were taking the subject based on certain considerations with a specific purpose.

The research sample conducts learning using a project-based e-learning model. Table 1 shows the syntax of the project-based e-learning model in this study. The project-based e-learning model in this study is integrated with Google Classroom. Figure 1 shows the display on google classroom, which contains materials, project assignments, discussion forums, and quizzes. The learning process in this study was carried out in four meetings. The first meeting aims to apply vector arithmetic operations (factual) and solve problems related to vectors geometrically (procedural). The second meeting seeks to understand position vectors, vector lengths, and unit vectors in the algebraic concept of vectors (conceptually), apply algebraic vector arithmetic operations (factual), and solve problems related to vectors algebraically (procedural). The third meeting aims to understand the scalar multiplication of two vectors (conceptual) and apply the scalar multiplication of two vectors to determine the angle between two vectors (factual). The fourth meeting aims to understand and apply the concept of orthogonal scalar projection and orthogonal vector projection.

Table 1. Project-based e-learning model syntax

Steps	Description
Questioning	The teacher conducted a virtual meeting to explain the learning topic and to ask several questions related to the topic presented.
Project Planning	Students develop plans for completing project assignments according to instructions.
Project Preparation	Students discuss to determine the right strategy for completing the project.
Project Completion	Students complete project tasks according to a predetermined strategy.
Arrange of Reports	Students compile a project report.
Evaluation	Students share their experiences during the completion of the project to reflect on the project activities and results.

Figure 1. Display of Google Classroom on the project-based e-learning model

This research begins with measuring Gregorc's mind style through a questionnaire. Gregorc's mind style was measured through a questionnaire arranged based on the characteristics of Concrete Sequential (CS), Concrete Random (CR), Abstract Sequential (AS), and Abstract Random (AR). Mathematical creative thinking abilities are measured using a description test on vector material using indicators consisting of fluency, flexibility, elaboration, and originality. Then, the researchers conducted triangulation to examine mathematical creative thinking ability through observation and interviews. Triangulation aims to identify aspects of mathematical creative thinking ability in each mind style of Gregorc.

Quantitative data analysis through ANOVA tests differences in mathematics creative thinking ability in each Gregorc mind style. While qualitative data analysis has four stages: data collection, data reduction, data presentation, and concluding. Data reduction is data simplification so that the data produces meaningful information. The presentation of data is a systematic and easy-to-understand data collection. Conclusion drawing aims to find the meaning of the data collected by looking for relationships, similarities, or differences to conclude answers to problems.

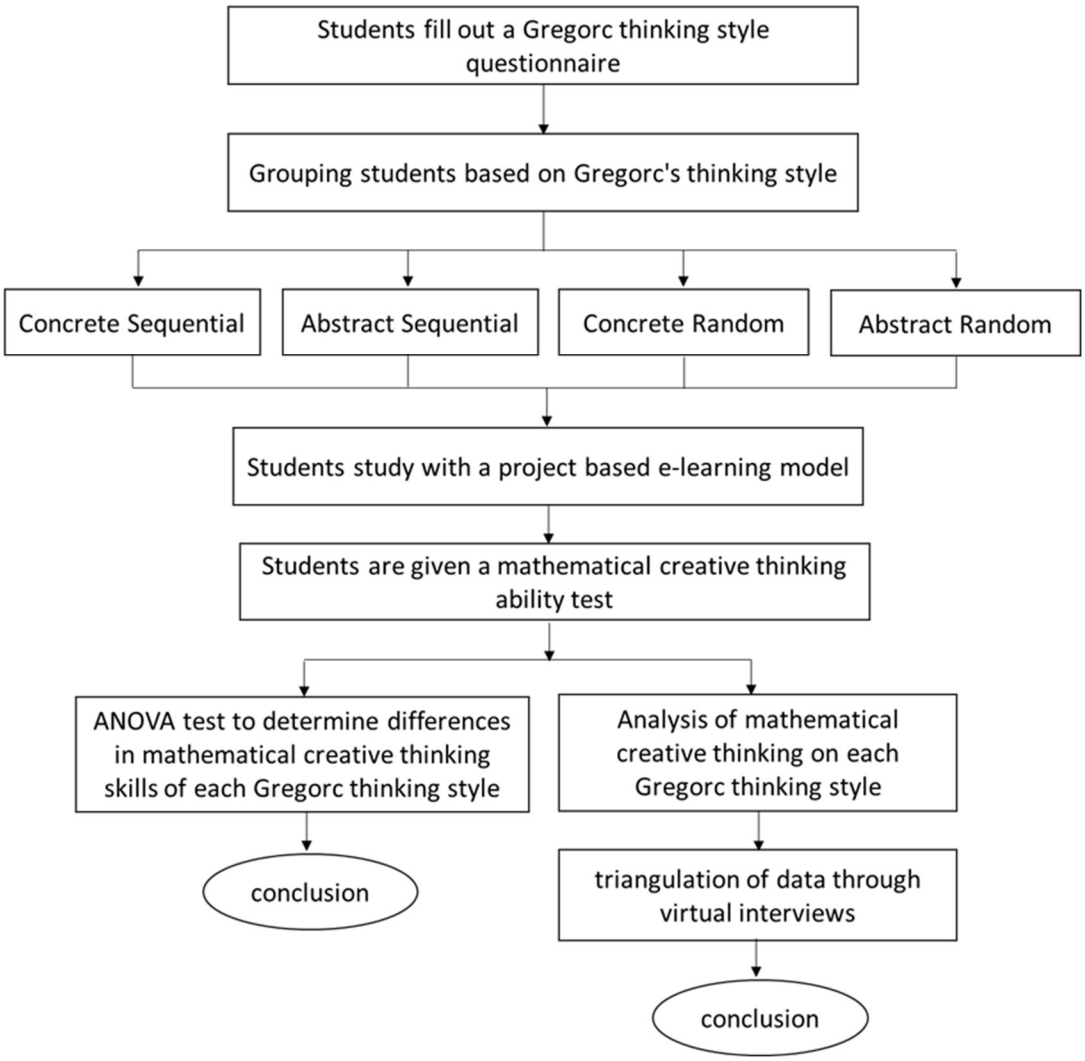

Figure 2. Research Design

Results and Discussion

The research results on Gregorc's mind style showed that 66.3% of the students were of the concrete sequential type, 20.2% of the students were of the concrete random type, and 13.5% were of the abstract random type. The study did not find students with the abstract sequential type of Gregorc mind style. The results are in line with the research of (Sahatcija & Ora, 2017), which state that concrete sequential is a mind style owned by most students.

The significance value of the ANOVA test from the pretest results of mathematical creative thinking ability is 0.001 <0.05, so there is a difference in students' average mathematical creative thinking ability in each Gregorc thinking style before learning with the project-based e-learning model. Further test results showed a significant difference in mathematical creative thinking abilities between students with CS and CR and CS and AR thinking styles. There was no significant difference in mathematical creative thinking ability between students with CS and AS, AS with CR, AS with AR, CR with AS, CR and AR. The average pretest of mathematical creative thinking ability with CS, AS, CR, and AR thinking styles were 20.30, 17.44, 15.40, and 15.12, respectively.

The significance value in the ANOVA test from the pretest results of mathematical creative thinking ability is 0.001 < 0.05, so there is a difference in students' average mathematical creative thinking ability in each Gregorc thinking style before learning with the project-based e-learning model. The significance value in the ANOVA test from the posttest results of mathematical creative thinking ability is 0.952 > 0.05, so there is no difference in the average posttest results of students' mathematical creative thinking ability in each Gregorc thinking style. Students with different Gregorc thinking styles who use the project-based e-learning model have similar mathematical creative thinking abilities. Based on the results of further tests, it was obtained that there was no significant difference in the post-test results of students' mathematical creative thinking ability for each difference in Gregorc's thinking style. The average posttest results of students' mathematical creative thinking ability with CS, AS, CR, and AR thinking styles were 81.15, 81.88, 80.93, 81, and 81.19, respectively. The results of further tests showed a significant difference in mathematical creative thinking ability between students with CS and CR thinking styles, CS and AR. There was no significant difference in mathematical creative thinking ability between students with CS and AS thinking styles, AS and CR, AS and AR, CR and AS, CR and AR. The average pretest of mathematical creative thinking ability with CS, AS, CR, and AR thinking styles were 20.30, 17.44, 15.40, and 15.12, respectively. Students with different Gregorc mind styles did not see a significant difference in the mathematical creative thinking test results when they learned using the project-based e-learning model. Therefore, the project-based e-learning model is an alternative learning model that can overcome differences in mind styles to develop mathematical creative thinking ability.

The project-based e-learning model is one in which the teacher facilitates students' completing projects independently. Through an understanding of differences in mind styles, the teacher encourages students to find learning patterns that suit their way of thinking. Khalifelu (2011) stated that every student could not be forced to learn in the same way as one another because they can find the best way of learning for themselves and make progress. Even Chegeni et al. (2016) stated that there is a relationship between creative thinking ability and a

person's thinking style. Elbaz et al. (2018) and Kassim (2013) also stated that there is a relationship between thinking style and mathematical creative thinking ability.

The project-based e-learning model can answer the challenge of being applied to students with various thinking styles because it can overcome the gap in students' mathematical creative thinking abilities. Although through different thinking processes, students in each Gregorc thinking style can achieve the same mathematical creative thinking abilities. Project-based learning encourages students to explore their ability to compile projects so that they can create new and diverse ideas. As Ralph (2016) stated, project-based learning enables students to construct ideas and actively develop various unique ideas. The results of the Djam'An et al. (2021) study showed that as many as 91% of students who took project-based learning obtained creativity results, including the very good category. Wijaya et al. (2021)also stated that project-based learning improves communication and problem-solving, creative thinking, and self-confidence.

The differences in Gregorc mind styles statistically do not show significant differences in mathematics creative thinking ability. Still, a detailed analysis is needed to identify aspects of mathematical creative thinking ability in each Gregorc mind style. As Isyrofinnisak et al., (2020) stated, each Gregorc style of thinking differs in achieving aspects of creative mathematical thinking. Gregorc mind style obtained in this study consisted of abstract random, concrete random, and concrete sequential. This study chose three research subjects for each mind style and analyzed the achievement of aspects of mathematical creative thinking ability. AR is a subject with an abstract random mind style, CR is a subject with a concrete random mind style, and CS is a subject with a concrete sequential mind style.

The aspect of mathematics creative thinking that stands out in CR subjects is originality. CR subjects can solve problems by presenting unique solutions that differ from the others. CR subjects try to answer questions by exploring their solution strategies, but they do not always follow the formula because CR subjects tend to find it challenging to memorize formulas, so they try to formulate solutions to problems in their way. This is supported by the characteristics of the concrete random mind style, in which they always want to try new things. Isyrofinnisak et al., (2020) also stated that the concrete random mind style has a strong determination to find problem-solving alternatives and do things in their way.

Researcher: Did you do this math test yourself?
CR subject: yes, I did it myself.
Researcher: What difficulties did you find in solving the problem?
CR subject: I had a bit of difficulty interpreting the problem to be presented in a picture and explaining the relationship between each part of the picture in detail. I discussed this with friends to understand the type of problem like that.
Researcher: What do you find interesting about the question?
CR subject: I can explore my abilities through questions that require me to state several answers. I also try to answer questions using the method that I present with steps to solve the problem in a language that I understand.

CR subjects did not achieve the elaboration aspect properly because CR subjects needed help to interpret the problem in detail. The test results showed that the CR subjects could compose a sketch according to the problem, but the CR subjects could not explain the sketch correctly. Fauzi, N.M., et al., (2017) stated that concrete random thinking style tends to have

difficulty understanding directions and instructions given in a structured manner. Therefore, the resulting solution does not explain the problem in detail. The concrete random mind style tended to ignore the directions and instructions provided. Therefore, the resulting solution does not explain the intended problem in detail.

On the other hand, CS subjects can achieve elaboration aspects well. The test results of CS subjects showed that CS subjects could compose sketches on math problems and explain in detail the meaning of the sketches. It is supported by the characteristics of a concrete sequential mind style, according to Tobias (2009) in Indah & Fardah, (2022), namely systematic, careful, and thorough. A concrete sequential mind style can receive, process, and remember information presented systematically and sequentially in a tangible form. Concrete sequential mind style always tries to complete assignments in earnest by understanding the information received one by one in detail.

On the other hand, the mathematical creative thinking test results showed that the originality aspect could not be achieved well by CS subjects. Even though the answers generated by CS subjects are correct, these answers cannot be categorized as unique solutions. It can be caused by the characteristics of concrete sequential mind style who have weak imaginations. CS subjects also tended to obey step-by-step instructions explained by the teacher in solving problems, so they had difficulty developing different solutions from those previously described.

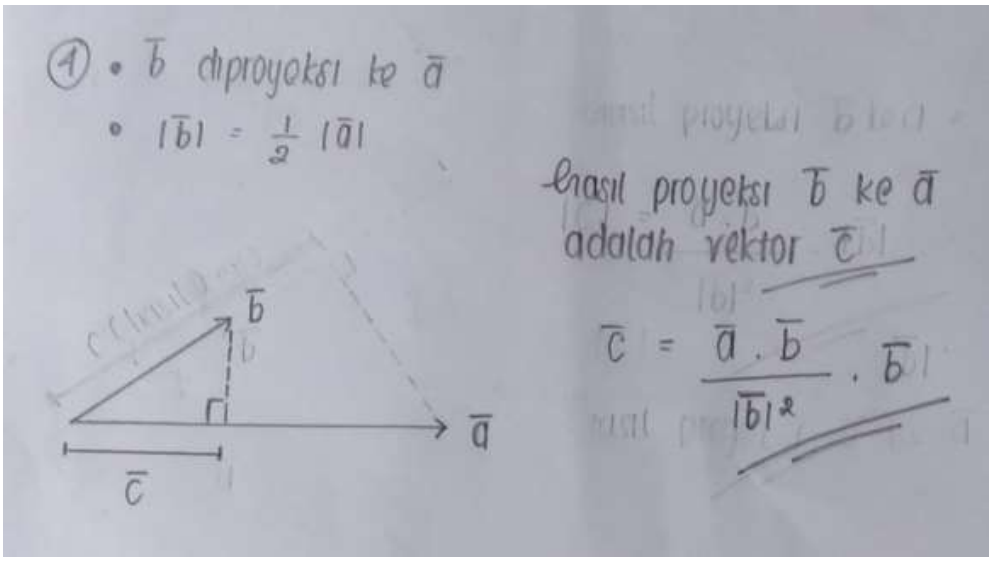

Figure 3. Elaboration Aspects on CS Subjects

In contrast to the CR and CS subjects, no aspect of mathematics creative thinking was most prominent in the AR subjects. AR subjects can achieve the originality aspect, although the score was higher than the CR subjects. It is due to the characteristics of abstract random mind style, according to Marulis, (2025), that abstract random mind styles absorb ideas and information and then reflect in their own way so that they are easy to understand and remember. Besides that, the characteristics of AR subjects are making decisions by prioritizing feelings compared to thoughts. Myers and Dyer (2006) state that the thought processes of abstract random mind style are anchored in feelings and prioritize emotions. Therefore, AR subjects have strong imaginations and can do things in their own way.

AR subjects achieved the elaboration aspect even though the results were no better than CS subjects. The test results show that AR subjects can arrange sketches according to the problem, but the illustrations of the sketches are not quite right. Ginting (2017) also stated that the abstract random mind style has difficulty explaining and providing precise details on a problem. Figure 4 shows the elaboration aspects achieved by AR subjects. AR subjects could compose sketches, but the descriptions provided did not fully describe the sketches.

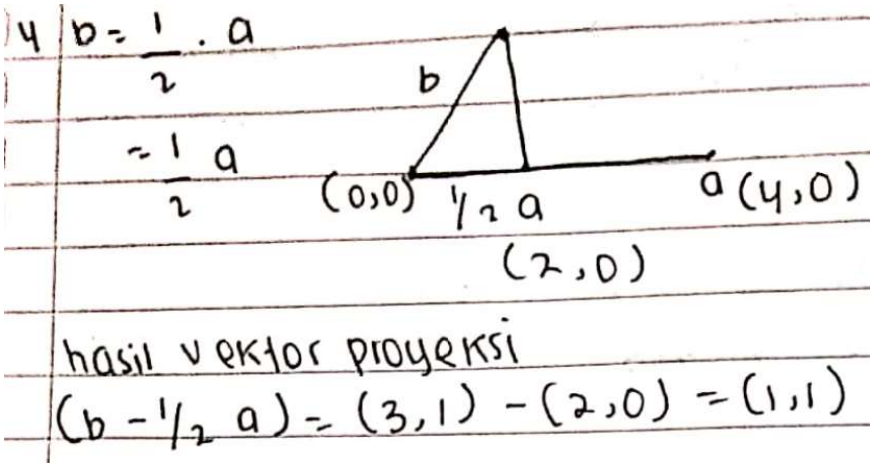

Figure 4 shows the elaboration aspects achieved by AR subjects.

AR subject achieved the elaboration aspect, although the results obtained were not better than those of the CS subject. The test results showed that the AR subject could sketch according to the problem, but his sketch illustration was incorrect. Ginting (2017) stated that the abstract random mind style has difficulty explaining and providing precise details on a problem.

The results of interviews with AR subjects showed that AR subjects have tried to achieve originality.

Researcher: Did you do this math test yourself?

AR subject: yes, I did it myself.

Researcher: What difficulties did you find in solving the problems?

AR subject: I did not experience significant difficulty. It was just that I lacked confidence in the answers I wrote.

Researcher: *Are you sure about the solution you found?*

AR subject: I tried to solve the problems based on my logic. However, I was not completely sure of the solution that I provided.

Researcher: What process do you use to solve problems?

AR subject: I try to reflect on the stages of solving the problem using various possible problem-solving strategies.

AR subjects can receive, process, and remember information presented spontaneously through imagination.

By absorbing various ideas, information, and impressions and then rearranging them through reflection, they can remember well if the information is made to their taste. Tobias (2009) in Indah & Fardah, (2022) stated that the abstract random mind style has high sensitivity and imaginative, idealistic, sentimental, spontaneous, and flexible properties. Myers & Dyer, (2006) abstract random mind style subjects view routine and regularity as boring and enjoy a

colorful and varied environment. Therefore, the abstract random mind style always tries to find innovations in solving problems.

Teeraputon & Nuankaew, (2020) stated that Gregor's mind style is an important factor in student attitudes and achievement. Each Gregorc's mind style has different characteristics to achieve mathematics creative thinking ability. The different characteristics of each mind style lead to differences in the attainment of mathematical creative thinking aspects (Pamungkas & Masduki, M, 2022) stated that there are prominent characters in each mind style, namely concrete sequential mind style, which is good at logical reasoning; concrete random mind style, who learn best in the process of problem-solving and situation analysis; and abstract random mind style are, interested in innovativeness. The difference in Gregorc's mind style is not an obstacle for students in achieving all aspects of mathematics creative thinking through learning with the project-based e-learning model.

Conclusion

Students with different Gregorc mind styles who received learning using the project-based e-learning model experienced no difference in mathematical creative thinking ability. The project-based e-learning model effectively addresses differences in mind styles to achieve mathematical creative thinking aspects. The project-based e-learning model can be used as an alternative distance learning model to encourage students to develop mathematical creative thinking abilities with different thinking styles. The project-based e-learning model also facilitates teachers in controlling each student, although they have different mind styles. Therefore, the project-based e-learning model is appropriate for the pandemic era, which requires students to learn from home. This study did not find students with random sequential mind styles. It cannot identify the strengths and weaknesses of students with random sequential mind styles to achieve aspects of creative mathematical thinking. Students with different mind styles have various ways of attaining creative mathematical thinking. Students with the concrete sequential mind style could achieve the elaboration aspect well but not the originality aspect. On the other hand, students with an abstract random mind style could achieve the originality aspect very well. It is supported by the characteristics of the abstract random mind style, namely innovation. A more comprehensive sample range is expected to be carried out in future studies to identify all types of Gregorc mind styles.

References

Aini, A. N., Mukhlis, M., Annizar, A. M., Jakaria, M. H. D., & Septiadi, D. D. (2020). Creative thinking level of visual-spatial students on geometry HOTS problems. *Journal of Physics: Conference Series*, *1465*(1). https://doi.org/10.1088/1742-6596/1465/1/012054

Alkathiri, F., Alshreef, S., Alajmi, S., Alsowayan, A., & Alahmad, N. (2018). A Systematic Review: The Relationship between Learning Styles and Creative Thinking Skills. *English Language and Literature Studies*, *8*(1), 34. https://doi.org/10.5539/ells.v8n1p34

Ayllon, M. E., Gomez, I. A., & Claver, J. B. (2016). Mathematical thinking and creativity through mathematical problem posing and solving. *Propósitos y Representaciones*, *4*(1), 169–218. https://eric.ed.gov/?id=EJ1126306

Bicer, A., & Bicer, A. (2023). Understanding young students' mathematical creative thinking processes through eye-tracking-stimulated recall interview. In *Mathematics Education Research Journal* (Vol. 35, Issue 2). Springer Netherlands. https://doi.org/10.1007/s13394-022-00429-7

Bolden, D. S., Harries, T. V., & Newton, D. P. (2010). Pre-service primary teachers' conceptions of creativity in mathematics. *Educational Studies in Mathematics*, *73*(2), 143–157. https://doi.org/10.1007/s10649-009-9207-z

Chegeni, N., Kamali, B., Noroozi, A., & Chegeni, N. (2016). General English Textbook Evaluation: A Closer Look at "Four Corners." *Theory and Practice in Language Studies*, *6*(12), 2325. https://doi.org/10.17507/tpls.0612.13

Djam'An, N., Bernard, & Sahid. (2021). Developing Students' Creativity in Building City Mathematics through Project Based Learning. *Journal of Physics: Conference Series*, *1899*(1), 0–7. https://doi.org/10.1088/1742-6596/1899/1/012147

Elbaz, A. M., Agag, G. M., & Alkathiri, N. A. (2018). How ability, motivation and opportunity influence travel agents performance: the moderating role of absorptive capacity. *Journal of Knowledge Management*, *22*(1), 119–141. https://doi.org/10.1108/JKM-07-2017-0308

Fauzi, M.N., Usodo, B., & Subanti, S. (2017). The Comparison of Learning Model Viewed from the Students Thinking Style. *Journal of Education and Learning (EduLearn)*, *11*(4), 327–331. https://doi.org/10.11591/edulearn.v11i4.6874

Ginting, S. A. (2017). A Facilitating Effective Teaching through Learning Based on Learning Styles and Ways of Thinking. *Dinamika Ilmu*, *17*(2), 165–173. https://doi.org/10.21093/di.v17i2.850

Hadar, L. L., & Tirosh, M. (2019). Creative thinking in mathematics curriculum: An analytic framework. *Thinking Skills and Creativity*, *33*(July), 100585. https://doi.org/10.1016/j.tsc.2019.100585

Hobri, H., Suharto, S., & Rifqi Naja, A. (2018). Analysis of students' creative thinking level in problem solving based on national council of teachers of mathematics. *Journal of Physics: Conference Series*, *1008*(1). https://doi.org/10.1088/1742-6596/1008/1/012065

Indah, P. N., & Fardah, D. K. (2022). Kesalahan Siswa Dalam Menyelesaikan Soal Cerita Matematika Ditinjau Dari Gaya Belajar Global – Analitik Disertai Scaffoldingnya. *MATHEdunesa*, *11*(2), 341–356. https://doi.org/10.26740/mathedunesa.v11n2.p341-356

Isyrofinnisak, F., Kusmayadi, T. A., & Fitriana, L. (2020). Mathematics creativity skill of student in junior high school based on students thinking style. *Journal of Physics: Conference Series*, *1538*(1). https://doi.org/10.1088/1742-6596/1538/1/012068

Kardoyo, Nurkhin, A., Muhsin, & Pramusinto, H. (2020). Problem-based learning strategy: Its impact on students' critical and creative thinking skills. *European Journal of Educational Research*, *9*(3), 1141–1150. https://doi.org/10.12973/EU-JER.9.3.1141

Kassim, H. (2013). The Relationship between Learning Styles, Creative Thinking Performance and Multimedia Learning Materials. *Procedia - Social and Behavioral Sciences*, *97*, 229–237. https://doi.org/10.1016/j.sbspro.2013.10.227

Khalifelu, Z. A. (2011). Learning Styles Classification : Learner Control Implications in Instruction and Education. *International Journal of Engineering Science*, *3*(12), 8538–8547.

Kristanto, A., Mustaji, M., & Mariono, A. (2017). The Development of Instructional Materials E-Learning Based On Blended Learning. *International Education Studies*, *10*(7), 10. https://doi.org/10.5539/ies.v10n7p10

Leikin, R., & Pitta-Pantazi, D. (2013). Creativity and mathematics education: The state of the art. *ZDM - International Journal on Mathematics Education*, *45*(2), 159–166. https://doi.org/10.1007/s11858-012-0459-1

Leikin, R., & Sriraman, B. (2017). *Advances in Mathematics Education Creativity and Giftedness Interdisciplinary perspectives from mathematics and beyond*. www.springer.com/series/8392

Marulis, L. M. (2025). Editorial: Advances in metacognition and reflection. *Frontiers in Developmental Psychology*, *3*. https://doi.org/10.3389/fdpys.2025.1579553

Mota, F. B., Jatobá Neta, A. L., & Cabral, B. P. (2024). Mapping the global research on feeding and eating disorders and autism spectrum disorder (2014–2023): A bibliometric and network analysis. *Research in Autism Spectrum Disorders*, *118*. https://doi.org/10.1016/j.rasd.2024.102497

Munahefi, D. N., Kartono, Waluya, S. B., & Dwijanto. (2020). ASPIRE model (analysis, scaffolding, project, investigation, reaction, and evaluation) for mathematical creative thinking ability. *Journal of Physics: Conference Series*, *1567*(2). https://doi.org/10.1088/1742-6596/1567/2/022099

Myers, B. E., & Dyer, J. E. (2006). the Influence of Student Learning Style on Critical Thinking Skill. *Journal of Agricultural Education*, *47*(1), 43–52. https://doi.org/10.5032/jae.2006.01043

Nadjafikhah, M., & Yaftian, N. (2013). The Frontage of Creativity and Mathematical Creativity. *Procedia - Social and Behavioral Sciences*, *90*(InCULT 2012), 344–350. https://doi.org/10.1016/j.sbspro.2013.07.101

Nuha, M. A., Waluya, S. B., & Junaedi, I. (2018). Mathematical creative process wallas model in students problem posing with lesson study approach. *International Journal of Instruction*, *11*(2), 527–538. https://doi.org/10.12973/iji.2018.11236a

Pamungkas, A. S., & Masduki, M. (2022). Student's Logical Reasoning Ability in Terms of Sequential Thinking Style. *Kreano, Jurnal Matematika Kreatif-Inovatif*. *13*(2), 257–268.

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. https://doi.org/10.12973/iejme/3962

Ralph, R. A. (2016). Post secondary project-based learning in science, technology, engineering and mathematics. *Journal of Technology and Science Education*, *6*(1), 26–35. https://doi.org/10.3926/jotse.155

Sahatcija, R., & Ora, A. (2017). *2017 UBT International Conference Thinking styles through the elements of contemporary methods Thinking Styles through the Elements of Contemporary Teaching Methods*.

Scott, G., Leritz, L. E., & Mumford, M. D. (2004). The effectiveness of creativity training: A quantitative review. *Creativity Research Journal*, *16*(4), 361–388. https://doi.org/10.1080/10400410409534549

Shwartz, H., Fuchs, A., Shwartz, H., Fuchs, A., Education, M., Arousal, C. C., & Fuchs, A. (2025). *Mathematics Education and Creativity -Influencing Cognitive Arousal , Self-Efficacy and Motivation-Meta-Analysis Article To cite this version : HAL Id : hal-05001561 Mathematics Education and Creativity - Influencing Cognitive Arousal , Self-Efficacy and* .

Teeraputon, D., & Nuankaew, P. (2020). Attitude and learning styles in different academic achievement of tertiary students. *Universal Journal of Educational Research*, *8*(11B), 6178–6184. https://doi.org/10.13189/ujer.2020.082255

Ul Ansar, M.R., & M.P. Ganesh. (2016). Cognitive Styles Research: A Review of Theory, Assessments and Applications. *International Journal of Indian Psychology*, *11*(1). https://doi.org/10.25215/1101.094

Ummah, S. K., Inam, A., & Azmi, R. D. (2019). Creating manipulatives: Improving students' creativity through project-based learning. *Journal on Mathematics Education*, *10*(1), 93–102. https://doi.org/10.22342/jme.10.1.5093.93-102

Wijaya, T. T., Zhou, Y., Ware, A., & Hermita, N. (2021). Improving the Creative Thinking Skills of the Next Generation of Mathematics Teachers Using Dynamic Mathematics Software. *International Journal of Emerging Technologies in Learning*, *16*(13), 212–226. https://doi.org/10.3991/ijet.v16i13.21535

Yaniawati, P., Kariadinata, R., Sari, N. M., Pramiarsih, E. E., & Mariani, M. (2020). Integration of e-learning for mathematics on resource-based learning: Increasing mathematical creative thinking and self-confidence. *International Journal of Emerging Technologies in Learning*, *15*(6), 60–78. https://doi.org/10.3991/ijet.v15i06.11915

Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281

Young, D., Snyder, M., Been, S., Steiner, J., Ben, M., Caplan, A., & Snyder, M. (2008). *ETAI-Forum-Vol.-XIX-No.-3-Summer-2008*. *XIX*(3).

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: a meta-analysis study. *Frontiers in Psychology*, *14*(July), 1–14. https://doi.org/10.3389/fpsyg.2023.1202728