INTERNATIONAL JOURNAL OF GEOMETRY RESEARCH AND INVENTIONS IN EDUCATION
Vol. 1 No. 2 (2024) 102-109

GRADIENT

https://journals.eduped.org/index.php/gradient
E-ISSN 2026-959X

Analogical Reasoning in Geometric Problem Solving: A Cognitive Analysis Based on Sternberg's Thinking Styles

Eva Mulyani[1,2*], Jailani[3], Hartono[4],
[1]Universitas Siliwangi, Jl Siliwangi No. 24 Tasikmalaya, 46115, Indonesia
[2]Universitas Negeri Yogyakarta, Jl. Colombo No.1 Sleman DIY, 55281, Indonesia
[3]Universitas Negeri Yogyakarta, Jl. Colombo No.1 Sleman DIY, 55281, Indonesia
[4]Universitas Negeri Yogyakarta, Jl. Colombo No.1 Sleman DIY, 55281, Indonesia

*Corresponding author: evamulyani@unsil.ac.id

Article Info

Received Sept 18, 2024
Revised Nov 31, 2024
Accepted Dec 28, 2024

Abstract

Analogical reasoning plays a vital role in mathematics learning, especially in helping students solve new problems by using structural similarities with known problems. Each student has a different thinking style, which influences how they process information to solve mathematical problems. This research aims to analyze the analogical reasoning thinking process in solving mathematical problems from the perspective of Sternberg's thinking styles. The study employs a qualitative approach with exploratory methods. This study involved 9th-grade students from a public junior high school in Tasikmalaya City, West Java. The results conclude that the complete and accurate analogical reasoning thinking process in solving mathematical problems is exhibited by the legislative, executive, judicial, local, and internal thinking styles.

Keywords: Analogical reasoning; Sternberg's thinking styles

How to cite: Mulyani, E., Jailani, J., and Hartono, H. (2024). Analogical Reasoning in Geometric Problem Solving: A Cognitive Analysis Based on Sternberg's Thinking Styles. *Journal of Geometry Research and Innovation in Education*, 1(2), 102-109, doi. https://doi.org/10.56855/gradient.v1i2.1234

1. Introduction

Analogical reasoning is an essential skill in mathematics education that helps students connect new problems with previous ones through structural similarities. This process supports problem-solving activities, enabling students to apply their existing knowledge to overcome new challenges (Sidney dan Thompson 2019). In receiving and understanding information to solve problems, an

individual's ability in this regard is influenced by differences in cognitive styles, including Sternberg's thinking styles, which classify individuals based on these distinctions (Kristanti dan Kriswandani 2018; Ummah dan Handayani 2019).

Understanding how Sternberg's thinking styles influence students' thought processes in analogical reasoning is crucial. Many students still face difficulties in solving mathematical problems using analogical reasoning due to differences in their thinking abilities (Maarif 2015). All components of analogical reasoning in problem-solving can be fulfilled by high-achieving students. However, students with moderate abilities can only meet some components, while low-achieving students struggle to fulfill even one component due to their inability to identify problems or critical information (Shute 2007).

Educators need to know the students' thinking process, because according to (Wilson, Mojica, dan Confrey 2013) By understanding how to think and how to process information, students will make educators know the extent of students' understanding of mathematics. Meanwhile, geometry, especially flat plane space is one aspect of mathematics that is abstract and often related to everyday life, so to understand it requires reasoning activities (Hohol 2019). Thus, knowing how the analogical reasoning process works in solving mathematical problems in the geometry of flat-sided geometric figures is necessary.

Sternberg's thinking style is divided into several types, including legislative, executive, judicial, monarchical, oligarchic hierarchy, anarchy, global, local, external, internal, liberal, and conservative thinking styles (Sternberg, in Gafoor and Lavanya 2008). Studies show a relationship between thinking style and the process of solving mathematical problems, where there are differences in the thinking process between students who have legislative, executive, and judicial thinking styles (Lestari dan Budiarto 2018). Research related to analogical reasoning and thinking styles has been conducted, including Analogical Reasoning In Solving Algebra Problems Viewed From Students' Mathematical Abilities (Mz 2024), Analysis of Reflective Student Analogy Reasoning in Solving Geometry Problems (Pradita dkk. 2021), Analogical reasoning on two dimensional geometry (Gunawan, Supriatna, dan Annisa Nur Fauzi 2021), Structuring students' analogical reasoning in solving algebra problem (Lailiyah dkk. 2018), but studies on the analogical thinking process by reviewing all types of Sternberg's thinking styles have not been conducted.

2. Methods

The research uses a qualitative approach, namely research in order to understand what is experienced by the research subject through descriptions in the form of words and language in a specific natural context (Moleong 2019), and exploratory methods, namely qualitative methods that aim to find out information about social conditions in depth.

This research was conducted at a public junior high school in Tasikmalaya, with subjects of grade IX C and IX K students selected based on certain considerations and objectives, where the determination of subjects was based on students who worked on analogical reasoning test questions based on analogical reasoning components without looking at whether they were right or wrong in solving them. Data were collected through test techniques with analogical reasoning test instruments in the form of one descriptive question on Flat-Sided Space Structures, questionnaire techniques with instruments in the form of Sternberg's thinking style questionnaires to categorize students' thinking styles as many as 56 statements, and interview techniques to find out more in-depth information about the analogical reasoning thinking process that had been given. Meanwhile, data analysis used the Miles and Hubermans model analysis technique consisting of data reduction, data presentation, and drawing conclusions/verification.

3. Results and Discussion

3.1. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematical Problems of Students with a Legislative Thinking Style

The analogical reasoning thinking process in solving mathematical problems is reviewed from the legislative thinking style, namely, at the entry stage, the legislative subject is able to identify elements related to the problem, group the information provided, and organize the known data, although not completely systematic, because it does not include calculations for finding the width and height of the aquarium, but instead directly uses the results. The legislative subject also decides on his own activities by writing down what is known according to what he has understood. This is in line with the opinion of Lestari & Budiarto (2018) that legislative is a person's thinking style that is free to determine something. Supported by research conducted by Strnberg (Rana, Rana, dan Rana 2022) that a person with a legislative thinking style understands the meaning of the problem that has been given.

At the attack stage, the legislative subject can propose a solution to the problem, try the solution to the source problem and the target problem correctly, and can convince others that every step in solving the source problem and the target problem that is carried out is correct even though it is not coherent because it does not write down the calculation to find the new width and height of Mr. Budi's aquarium and directly uses the results of the calculation to find the new volume of Mr. Budi's aquarium. The legislative subject can create or create his own way of solving the problem. This is in line with Sternberg's opinion (Alifiyah dan Kurniasari 2019) that someone with a legislative thinking style is someone who tends to choose activities based on creative planning. With this creative plan, legislative students in solving problems can plan and create and show different ways from what is common or can be said to be unusual ways. This is in line with research conducted by Lestari and Budiarto (2018) that legislative students fulfill the creative flexibility indicator because students who have a legislative thinking style think about and plan different ways of solving problems.

At the review stage, the legislative subject can check the accuracy of all calculations made, can reflect on ideas in solving such as making conclusions about answers to source problems and target problems correctly, mentioning which parts are difficult and what can be learned from the solution made and can find other ways to solve and the results are the same in finding 3/4 of the volume of Mr. Ahmad's aquarium and finding 7/8 of the volume of Mr. Budi's aquarium.

3.2. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematical Problems of Students with a Executive Thinking Style

The analogical reasoning thinking process in solving mathematical problems is reviewed from the executive thinking style, namely, at the entry stage the executive subject can find things involved in the problem, can group information from the problem, and can organize what is known. This is in line with research conducted by Putri, Sagala, and Listiana (2022) that a person with an executive thinking style understands the meaning of the problem by reading one piece of information provided in the question from top to bottom and providing reasons why the problem mentioned is as it is.

At the attack stage, the executive subject can propose a solution to the problem, try the solution to the source problem and the target problem correctly, and convince others that each step of solving the source problem and the target problem that is done is correct. The executive subject is accustomed to using solutions in solving the problem, especially with the first method. This shows the characteristics of the executive thinking style, namely preferring to choose things that are structured or made in advance. This is in line with Sternberg's opinion (Alifiyah dan

Kurniasari 2019) that people who have an executive thinking style prefer to apply rules or formulas that are commonly used to solve a problem. Supported by research conducted by Lestari and Budiarto (2018) that students with an executive thinking style do not fulfill the creative thinking indicators in redefinition (formulation) because students with an executive thinking style do not plan and show different ways to what is common to solve problems.

At the review stage, the executive subject can check the accuracy of all calculations made, can reflect on ideas in solving such as making conclusions about answers to source problems and target problems correctly, mentioning which parts are difficult and what can be learned from the solution made and can find other ways to solve and the results are the same in finding 3/4 of the volume of Mr. Ahmad's aquarium and finding 7/8 of the volume of Mr. Budi's aquarium.

3.3. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematical Problems of Students with Judicial Thinking Style

The analogical reasoning thinking process in solving mathematical problems is reviewed from the judicial thinking style, namely, at the entry stage the judicial subject can find things involved in the problem, can group information from the problem, and can organize what is known. At the attack stage, S-YU can submit a guess at solving the problem, try the guess at solving the source problem and the target problem correctly, and can convince others that each step in solving the source problem and the target problem that is carried out is correct. The judicial subject compares and assesses between the usual solution methods and the rarely used solution methods. In accordance with the opinions of Heong, Adam, and Kiong (2009) that individuals with a judicial thinking style like activities such as criticizing, giving views and assessing people or ways of working, so this group tends to like problems that can be analyzed and assessed regarding their solution ideas. At the review stage, S-YU can check the accuracy of all calculations made, can reflect on ideas in solving such as making conclusions about answers to source problems and target problems correctly, mentioning which parts are difficult and what can be learned from the solution made and can find other ways of solving and the results are the same in finding 3/4 of Mr. Ahmad's aquarium volume and finding 7/8 of Mr. Budi's aquarium volume.

3.4. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematics Problems of Students with a Global Thinking Style

The analogical reasoning thinking process in solving mathematical problems is reviewed from the local thinking style, namely, at the entry stage, the global subject can find things involved in the problem, can group information from the problem, and can organize what is known even though it is not coherent because it only writes down the calculation results in finding the initial width and height of Mr. Budi's aquarium. At the attack stage, the global subject can submit a guess to solve the problem, try to guess the solution to the source problem and the target problem correctly even though it is not coherent in some of the steps of the work because it only writes down the calculation results such as in finding the new width and height values of Mr. Budi's aquarium and finding the time difference needed by Mr. Budi and Mr. Ahmad, and convincing others that every step in solving the source problem and the target problem that is done is correct. The global subject only writes down the calculation results, which is in accordance with the characteristics of the global thinking style, namely ignoring or not liking detailed things. In line with the previous opinion of Romadhani and Lukmana (2018). At the review stage, the global subject can check the accuracy of all calculations made, can reflect on ideas in the solution such as mentioning which parts are difficult and what can be learned from the solution made and making conclusions about the answer to the source problem correctly but not making conclusions about the answer to the

target problem, and can find other ways of solving and the results are the same in finding 3/4 of the volume of Mr. Ahmad's aquarium and finding 7/8 of the volume of Mr. Budi's aquarium.

3.5. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematics Problems of Students with Local Thinking Styles

The analogical reasoning thinking process in solving mathematical problems is reviewed from the local thinking style, namely, at the entry stage the local subject can find things involved in the problem, can group information from the problem, and can organize what is known. At the attack stage, the local subject can submit a guess at solving the problem, try the guess at solving the source problem and the target problem correctly, and convince others that every step in solving the source problem and the target problem that is done is correct. This shows the characteristics of the local thinking style, namely preferring to identify and work in detail on certain parts of the task before moving on to other parts. In line with the opinion of Romadhani and Lukmana (2018) that someone with a local thinking style tends to enjoy being involved in tasks that allow them to work in detail, prefer to work on tasks in detail and focus on specific things. At the review stage, local subjects can check the accuracy of all calculations made, can reflect on ideas in solving such as making conclusions about answers to source problems and target problems correctly, mentioning which parts are difficult and what can be learned from the solution made and looking for other ways to solve and the results are the same in finding 3/4 of Mr. Ahmad's aquarium volume and finding 7/8 of Mr. Budi's aquarium volume.

3.6. Analysis of the Analogy Reasoning Thinking Process in Solving Mathematics Problems of Students with External Thinking Styles

The analogical reasoning thinking process in solving mathematical problems is reviewed from an external thinking style, namely, at the entry stage the external subject can find things involved in the problem, can group information from the problem, but is less able to organize what is known because in the process they forget to write down the information and are less coherent because they only write down the calculation results in finding the initial width and height of Mr. Budi's aquarium. At the attack stage, the external subject can submit a guess at solving the problem, try guessing the solution to the source problem and the target problem even though it is less coherent in some steps of the process because they only write down the calculation results such as in determining the new width and height of Mr. Budi's aquarium and are less careful so that they get the wrong final answer, and are less able to convince others that each step in solving the source problem and the target problem that is done is correct. The external subject explained that the information from the problem was not reread so that it used incorrect information and in the process did not write down the information. This shows the characteristics of the external thinking style of the external subject, namely extrovert where they can respond quickly. In accordance with Suryabrata's opinion (Halima, Trapsilasiwi, and Oktavianingtyas 2020) which states that one of the characteristics of extroverts is generally responding quickly but their answers tend to be wrong because they are not careful. At the review stage, external subjects were less able to check the accuracy of the calculations carried out in several steps of the solution such as when finding the time needed to fill 3/4 of Mr. Ahmad's aquarium volume, finding the difference in time needed and the difference in electricity consumption used by Mr. Budi and Mr. Ahmad, being able to reflect on ideas in the solution such as mentioning which parts are difficult and what can be learned from the solution carried out but not being able to draw conclusions about the answers to the source and target problems correctly, and being able to find other ways to solve the problem and the results are the same in finding 3/4 of Mr. Ahmad's aquarium volume and finding 7/8 of Mr. Budi's aquarium volume.

3.7. Analysis of the Analogy Thinking Process in Solving Mathematical Problems of Students with Internal Thinking Style

The analogical reasoning thinking process in solving mathematical problems is reviewed from the internal thinking style, namely, at the entry stage S-IN can find things involved in the problem, can group information from the problem, and can organize what is known. This shows the characteristics of S-IN's internal thinking style, namely introverted where they tend to be careful. In line with the opinion of Burtaverde and Mihaila (Halima, Trapsilasiwi, dan Oktavianingtyas 2020) that introverted individuals tend to focus and have a high fear of failure, making them more careful. At the attack stage, S-IN can propose a solution to the problem, try to guess the solution to the source problem and the target problem correctly but take longer to think, and convince others that every step in solving the source problem and the target problem that is done is correct. Based on the interview results, S-IN seemed silent before being able to express the conclusion of the relationship between the source problem and the target problem, namely that both use the cuboid volume formula to solve it. S-IN thought for a long time and seemed silent before answering the questions asked by the researcher regarding the correctness of the steps in solving the source problem that had been carried out. This shows the characteristics of the S-IN internal thinking style, namely introverted, which tends to be careful. In line with the opinion of Burtaverde and Mihaila (Halima et al. 2020) that an introvert tends to be careful in doing a job so that it takes longer to think. At the review stage, S-IN can check the accuracy of all calculations made, can reflect on ideas in solving such as making conclusions about answers to source problems and target problems correctly, mentioning which parts are difficult and what can be learned from the solution made and can find other ways to solve and the results are the same in finding 3/4 of the volume of Mr. Ahmad's aquarium and finding 7/8 of the volume of Mr. Budi's aquarium but it takes a long time to express it. S-IN can check the accuracy of all calculations made but it takes quite a long time.

4. Conclusions

The following are the conclusions of the research results: (1) Students who have legislative, executive, judicial, local and internal thinking styles go through the entry, attack and review stages completely and correctly. (2) Students who have a global thinking style go through the entry and attack stages completely and correctly, but cannot go through the review stage completely and correctly because at the review stage they cannot make conclusions about the answer to the target problem. (3) Students who have an external thinking style cannot go through the entry, attack and review stages completely and correctly because at the entry stage they are less able to organize what is known, at the attack stage they get incorrect answers, and at the review stage they are less able to check the accuracy of the calculations carried out and cannot make conclusions about the answer correctly. (4) Paying attention to the analogical reasoning thinking process in solving mathematical problems from the seven thinking styles, the analogical reasoning thinking process in solving mathematical problems that is complete and correct is the legislative, executive, judicial, local and internal thinking style.

Acknowledgments

The author would like to express his deepest gratitude to those who have provided support during the implementation of this research. The author would like to express his gratitude to LPPM Siliwangi University for funding research through the Competency Development Research Scheme (PPKOM); Prof. Dr. Jailani, M.Pd and Dr. Hartono, M.Si. for guidance, constructive input, and encouragement during the process of preparing and completing this research.

Conflict of Interest

The author would like to reveal that this research is supported by Mathematics Education FKIP Siliwangi University and UNY, which may be considered to have an influence on the results of the research. However, the author guarantees that all data and analysis are carried out independently and objectively.

References

Alifiyah, Y. R., dan I. Kurniasari. 2019. "Identifikasi Tingkat Berpikir Kreatif dalam Memecahkan Masalah Open Ended Ditinjau dari Gaya Berpikir Sternberg." *Jurnal Ilmiah Pendidikan Matematika* 8(2):216–22.

Gafoor, K. A., dan M. P. Lavanya. 2008. "Thinking styles and achievement of higher secondary students." *Edutracks* 8(2):38–43.

Gunawan, Supriatna, dan Dea Annisa Nur Fauzi. 2021. "Analogical Reasoning on Two Dimensional Geometry." *Journal of Physics: Conference Series* 1778(1):012007. doi: 10.1088/1742-6596/1778/1/012007.

Halima, N., D. Trapsilasiwi, dan E. Oktavianingtyas. 2020. "Profil kemampuan komunikasi matematis siswa dalam menyelesaikan soal sistem persamaan linear tiga variabel (spltv) ditinjau dari kepribadian extrovert dan introvert." *KadikmA: Jurnal Matematika dan Pendidikan Matematika* 11(3):1–10.

Heong, Y. M., N. N. Adam, dan T. T. Kiong. 2009. "Kepentingan Fungsi Gaya Berpikir Sternberg dalan Institusi Pengajian Tinggi." Hlm. 1–11 dalam *International Conference on Teaching and Learning in Higher Education 23-25 November 2009 Kuala Lumpur*.

Hohol, Mateusz. 2019. *Foundations of Geometric Cognition*. London: Routledge.

Kristanti, D. Y., dan Kriswandani. 2018. "Analisis Penalaran Adaptif dalam Menyelesaikan Soal Polyhedron Ditinjau dari Gaya Belajar dan Gaya Berpikir." Hlm. 249–57 dalam *Prosiding Seminar Nasional Pendidikan Matematika Etnomatnesia*.

Lailiyah, S., T. Nusantara, C. Sa'dijah, E. B. Irawan, Kusaeri, dan A. H. Asyhar. 2018. "Structuring Students' Analogical Reasoning in Solving Algebra Problem." *IOP Conference Series: Materials Science and Engineering* 296:012029. doi: 10.1088/1757-899X/296/1/012029.

Lestari, L. B., dan M. T. Budiarto. 2018. "Profil Berpikir Kreatif Siswa dalam Memecahkan Masalah Matematika Open Ended Berdasarkan Gaya Berpikir Sternberg Menurut Fungsinya." *Jurnal Ilmiah Pendidikan Matematika* 2(7):240–47.

Maarif, Samsul. 2015. "Improving Junior High School Students' Mathematical Analogical Ability Using Discovery Learning Method." *International Journal of Research in Education and Science* 2(1):114. doi: 10.21890/ijres.56842.

Moleong, J. L. 2019. *Metodologi Penelitian Kualitatif*. Bandung: PT Remaja Rosdakarya.

Mz, Muhammad Zainuddin. 2024. "Analogical Reasoning In Solving Algebra Problems Viewed From Students' Mathematical Abilities." *. . E* 04.

Pradita, Diyah Ayu Rizki, Maswar Maswar, Mohammad Tohir, Junaidi Junaidi, dan Dwi Nur Hadiyansah. 2021. "Analysis of Reflective Student Analogy Reasoning in Solving Geometry

Problems." *Journal of Physics: Conference Series* 1783(1):012105. doi: 10.1088/1742-6596/1783/1/012105.

Putri, M. T., V. Sagala, dan Y. Listiana. 2022. "Profil Berpikir Kritis Siswa dalam Memecahkan Soal High Order Thinking Berdasarkan Gaya Berpikir Sternberg Menurut Fungsinya." *Gauss: Jurnal Pendidikan Matematika* 5(1):50–59.

Rana, Anjali, Raksha Rana, dan Surya Rana. 2022. "Thinking Styles: A Portrayal of an Individual's Persona."

Romadhani, F. D., dan D. N. Lukmana. 2018. "Correlation between students' thinking style and academic achievement." *PROJECT: Professional Journal of English Education* 1(4):337–41.

Shute, Valerie J. 2007. "Focus On Formative Feedback." *ETS Research Report Series* 2007(1). doi: 10.1002/j.2333-8504.2007.tb02053.x.

Sidney, Pooja G., dan Clarissa A. Thompson. 2019. "Implicit Analogies in Learning: Supporting Transfer by Warming Up." *Current Directions in Psychological Science* 28(6):619–25. doi: 10.1177/0963721419870801.

Ummah, S. K., dan T. H. Handayani. 2019. "Identifikasi Gaya Berpikir Matematis Mahasiswa Melalui Penyelesaian Permasalahan Higher-Order Thinking." *Jurnal Elemen* 5(2):155–59.

Wilson, P. Holt, Gemma F. Mojica, dan Jere Confrey. 2013. "Learning Trajectories in Teacher Education: Supporting Teachers' Understandings of Students' Mathematical Thinking." *The Journal of Mathematical Behavior* 32(2):103–21. doi: 10.1016/j.jmathb.2012.12.003.