ANALYSIS OF CATEGORICAL SYLLOGISM SKILLS IN ELEMENTARY SCHOOL STUDENTS: A CASE STUDY IN GMG VILLAGE

Margareta[1], Zahra Shafira[2], Octarifa Angela[3], Jap Tji Beng[4] & Sri Tiatri[5]

[1]Undergraduate of Psychology, Universitas Tarumanagara, Jakarta
Email: margareta.705210239@stu.untar.ac.id
[2]Undergraduate of Psychology, Universitas Tarumanagara, Jakarta
Email: zahra.705210249@stu.untar.ac.id
[3]Undergraduate of Information System, Universitas Tarumanagara, Jakarta
Email: octarifa.825210106@stu.untar.ac.id
[4]Faculty of Information Technology, Universitas Tarumanagara, Jakarta
Email: t.jap@untar.ac.id
[5]Faculty of Psychology, Universitas Tarumanagara, Jakarta
Email: sri.tiatri@untar.ac.id

ABSTRACT

In the era of Industry 4.0, a fundamental necessity required to confront change is the ability to think. However, in its implementation in Indonesia, there are still schools that do not teach thinking skills in their learning activities. Yet, one crucial skill to develop since elementary school is categorical syllogism, which is the ability to categorize two premises. The application of categorical syllogism can foster logical, analytical, and critical thinking skills, which are essential for improving students' problem-solving abilities. Therefore, this research is important to conduct in order to assess the level of categorical syllogism skills among elementary school students in Indonesia, with a case study in GMG Village. This research utilized a quantitative research method. The participants in this study were 16 third-grade elementary school students and 11 fourth-grade elementary school students. Participants were selected using non-probability sampling technique with purposive sampling method. Data collection was conducted through a critical thinking questionnaire administered after participants received instructions and examples on how to proceed. The research questionnaire consisted of 6 items, with each question measured using a Likert scale ranging from 1 to 3. The research results indicate that out of 27 students, none of them were able to think in terms of categorical syllogism. This outcome suggests the need for improvement and development of learning methods that incorporate categorical syllogism thinking. It is hoped that this research can serve as a basis for evaluating and further implementing categorical syllogism skills in schools.

Keywords: categorical syllogism, students, elementary school

1. PREFACE

As the demands of advancing times progress, entering into Industry 4.0, individuals must adapt and develop their capabilities (Aspernäs et al., 2023). One of the skills that every individual needs to develop to cope with this development is in the aspect of thinking ability. Thinking is a fundamental skill possessed by every individual, yet not all individuals can think well, and not all educators can teach it (Ennis, 2011; Pithers & Soden, 2000). In reality, thinking ability is one of the crucial factors that can determine an individual's success in their career and higher education pursuits.

Thinking skills are highly essential in everyday life for individuals to evaluate information, make decisions, and predict the consequences of their choices. When facing daily challenges, individuals with good thinking skills tend to be more adaptive, creative, and efficient in overcoming obstacles. For example, the lack of thinking skills in Indonesia can be observed in the minimal concern of the public towards traffic safety despite knowing its consequences. The low thinking skills among the Indonesian population have become a focus of concern for experts because it can affect other

aspects of community life (Tiatri & Tji Beng, 2015). Therefore, it is important for every individual to develop and enhance thinking skills that can help navigate various everyday situations.

One method that can be applied to train and enhance thinking skills is by using categorical syllogism (Tiatri et al., 2023). According to Aristoteles, a syllogism is a set of premises and a conclusion, all of which are categorical and structured in a subject-predicate format (Stovall, 2021). Syllogism is a deductive method for drawing conclusions that can be either general or specific depending on its premises, with the condition that if all premises are true, then the conclusion is also true, but if any premise is false, then the conclusion is also false. A syllogism consists of two premises and a conclusion, where each premise and conclusion have two terms (subject and predicate) (Sethy, 2021; Tiatri et al., 2023). Aristoteles (1973) proposed that syllogism can be interpreted to form a rational structure by combining logical relationships in human perception.

In everyday life, individuals often reason using syllogistic abilities to determine logical conclusions or choices based on premises and other factors (Tessler et al., 2022). According to Senturk et al. (2021), the syllogistic system is one component that plays a crucial role in formal logic. Additionally, categorical syllogism can also help individuals confront any complex and ever-changing challenges. Specifically, categorical syllogism is a deductive argument consisting of two premises and one conclusion based on these premises (Pfeifer & Sanfilippo, 2023; Riesterer et al., 2020; Van Rooij & Xie, 2020). Categorical syllogism strictly adheres to all norms and rules of formal syllogism, which is a deductive conclusion. Categorical syllogism consists of three categorical statements: the major premise (general), the minor premise (specific), and the conclusion (Tiatri et al., 2023).

Gursoy et al. (2020) stated that categorical syllogism is the most crucial part of the human logic and thinking system. Previous research has also found that categorical syllogism has been extensively studied as a model of reasoning logic (Wasielewski et al., 2021). This highlights the importance of implementing learning involving categorical syllogism to hone thinking skills from childhood. As children begin to learn, the ability to draw logical conclusions from the information provided becomes more critical as the complexity of learning increases (García-Madruga et al., 2022). According to Tiatri et al. (2023), the ability in categorical syllogism is important to be developed by teachers in schools, especially when students are at the elementary school level.

Starting from the elementary school level, Indonesian children need to master skills that can support them in facing the progress and development of the times (Tiatri et al., 2020). At the elementary school level, students begin to learn to develop logical, critical, categorical, creative, and analytical thinking skills. However, not all students can independently develop thinking skills, especially categorical syllogism, well. Thus, the contribution of educators and schools is greatly needed to teach these thinking skills to students. Contributions that can be made to develop categorical syllogism thinking skills may include explanations, guidance, training, and implementation in classroom learning.

Students' categorical syllogism thinking skills can be developed through implementing learning that prioritizes interaction between teachers and peers through discussions and questioning (Tiatri et al., 2020). O'Reilly et al. (2022) found in their research that teachers who utilize discussion and question-and-answer approaches in the learning process successfully enhance children's thinking

abilities. The question-and-answer approach can be implemented using various types of questions, such as open-ended questions and closed questions, to encourage student thinking. This process can help students solve problems systematically, formulate logical arguments, and develop other skills needed in further education levels. Additionally, the elementary school education system also plays a significant role in students' academic fields by introducing basic subjects such as mathematics, language, science, and social studies. The success rate of the Indonesian education system can be assessed by comparing it with other international education systems through evaluations conducted by PISA.

PISA (Programme for International Student Assessment) is a program designed to evaluate students' abilities in problem-solving, critical thinking, and effective communication. This program measures and compares the mathematical, reading, and science abilities of 15-year-old students with participating countries (Hopfenbeck et al., 2018). The comparison can be used as an evaluation to shape an education system that helps students face challenges and succeed in the future. The results of PISA 2023 show that the mathematical, reading, and science abilities of students in Indonesia are still relatively low compared to other countries, with Indonesia ranking 69th out of 81 countries (PISA, 2023; Awalianti, 2024). This ranking indicates that improving students' thinking skills needs to be the main focus in improving the education system in Indonesia.

Based on the above description, the researcher recognizes the importance of applying categorical syllogism thinking skills in everyday life from an early age. The researcher realizes that implementing learning that includes categorical syllogism thinking skills can be effectively applied from the elementary school level. Therefore, this research is conducted to determine the level of students' thinking skills in Indonesia in applying categorical syllogism to a problem. The researcher conducted this research using a case study in GMG Village. This research is expected to serve as an evaluation tool for further learning and application of categorical syllogism in schools.

2. RESEARCH METHOD
This research was conducted in January 2024 and utilized quantitative research methodology. The participants of this study consisted of 27 elementary school students in GMG Village, comprising both third and fourth-grade classes. There were 16 students in the third-grade class and 11 students in the fourth-grade class. Participants were selected using non-probability sampling technique with purposive sampling method. Data were obtained by distributing questionnaires to students regarding their critical thinking skills. Before commencing the questionnaire, the researcher provided instructions on how to fill it out, engaged in discussions, and gave examples of questionnaire completion. Documentation in the form of photos during the data collection process at the GMG Village Elementary School is attached in Figure 1 and Figure 2.

The critical thinking questionnaire given to participants consisted of 6 items related to categorical syllogism thinking skills. Each question was measured using a Likert scale with options ranging from 1 to 3, namely: (1) Doesn't make sense, (2) Unsure, and (3) Makes sense. Students were also able to provide brief reasons for their opinions and why they chose one of the available answers.

Figure 1
The Data Collection Process for the Fourth-Grade Students in GMG Village

Figure 2
The Data Collection Process for the Third-Grade Students in GMG Village

3. RESULTS AND DISCUSSIONS

The participants in this study consisted of 27 elementary school students from GMG Village. The students selected by the researcher included 16 third-grade students and 11 fourth-grade students. There were 16 female participants and 11 male participants. The frequency distribution of participants can be seen in Figures 3 and 4.

Table 1
Frequency of Participant's Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Boy	11	40.7	40.7	40.7
	Girl	16	59.4	59.4	100.0
	Total	27	100.0	100.0	

Table 2
The Frequency of Participant's Grade

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Third Grade	16	59.3	59.3	59.3
	Fourth Grade	11	40.7	40.7	100.0
	Total	27	100.0	100.0	

In the research data, the researcher found that out of 27 students, based on the 6 items of questions provided, none of the students were able to answer all items correctly. 2 students answered 5 questions correctly (7.4%). 6 students answered 4 questions correctly (22.2%). 12 students answered 3 questions correctly (44.4%). 7 students still were unable to think categorically in syllogisms.

The majority of students scored correctly on 3 items, with a total of 12 students achieving this score (44.4%). Overall, the highest total correct score achieved by students was 5 items, with a total of 2 students (7.4%) reaching this score. The frequency distribution of the total correct answers obtained by participants overall can be seen in Figure 5.

Table 3
The frequency of Correct Answers from Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.7	3.7	3.7
	2.00	6	22.2	22.2	25.9
	3.00	12	44.4	44.4	70.4
	4.00	6	22.2	22.2	92.6
	5.00	2	7.4	7.4	100.0
	Total	27	100.0	100.0	

Below is the table analyzing the participants' answers in GMG Elementary School:
For the first question, the majority of participants answered correctly, totaling 20 individuals. There were 4 participants who answered incorrectly, while 3 participants were unsure. The percentage results can be seen in Table 1.

Tabel 4
Results of the First Question Item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 1	20	4	3	27
Percentage (%)	74	15	11	100

For the second question item, the majority of participants answered the question correctly, totaling 15 individuals. There were 6 participants who answered incorrectly, while 6 participants were unsure. The percentage results can be seen in Table 2.

Tabel 5
Results of the second question item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 2	15	6	6	27
Percentage (%)	56	22	22	100

For the third question item, the majority of participants answered the question correctly, totaling 19 individuals. There were 5 participants who answered incorrectly, while 3 participants were unsure. The percentage results can be seen in Table 3.

Table 6
Results of the third question item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 3	19	5	3	27
Percentage (%)	70	19	11	100

For the fourth question item, the majority of participants answered the question incorrectly, totaling 14 individuals. There were 14 participants who answered correctly, while 7 participants were unsure. The percentage results can be seen in Table 4.

Table 7
Results of the fourth question item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 4	6	14	7	27
Percentage (%)	22	52	26	100

For the fifth question item, the number of participants who answered the question correctly and incorrectly is the same, which is 11 individuals each. There were 5 participants who were unsure. The percentage results can be seen in Table 5.

Table 8
Results of the fifth question item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 5	11	11	5	27
Percentage (%)	41	41	19	100

For the sixth question item, the majority of participants have answered the question correctly, totaling 12 individuals. There were 11 participants who answered incorrectly, while 4 participants were unsure. The percentage results can be seen in Table 6.

Table 9
Results of the sixth question item

	Correct	Incorrect	Unsure	Total
Categorical Syllogism number 6	12	11	4	27
Percentage (%)	44	41	15	100

4. CONCLUSIONS AND SUGGESTIONS

This research discusses the categorical syllogism thinking skills of third and fourth-grade students in GMG Village. The aim of this study is to determine the level of categorical syllogism among students, thus serving as an evaluation for the development and implementation of categorical syllogism in school lessons. Based on the results obtained through the critical thinking questionnaire, some students have started to answer questions well. However, these results cannot be used as evidence that students are fully capable of categorical syllogism thinking because the results are obtained by comparing them to their peers only.

Categorical syllogism skills need to be the primary focus as they form the basis of children's development in combining logical relationships and training to solve problems systematically. Based on the above research, the researcher suggests to schools and teachers to pay more attention to the development of categorical syllogism thinking skills in students. Schools and teachers are also advised to provide learning and training related to categorical syllogism skills so that students can gradually improve and apply them. By prioritizing learning and training that emphasizes categorical

syllogism skills, schools can prepare students to face more complex academic challenges in the future.

REFERENCE
Aspernäs, J., Erlandsson, A., & Nilsson, A. (2023). Motivated formal reasoning: Ideological belief bias in syllogistic reasoning across diverse political issues. *Thinking and Reasoning*, *29*(1), 43–69. https://doi.org/10.1080/13546783.2022.2038268.

Aristoteles, A (1973). *Aristotle in twenty-three volumes*. Harvard University Press.

Ennis, R. (2011). Critical thinking: Reflection and perspective part ii. *Inquiry: Critical Thinking Across the Disciplines, 26*(2), 5–19. https://doi.org/10.5840/inquiryctnews201126215.

García-Madruga, J. A., Orenes, I., Vila Chaves, J. Ó., & Gómez-Veiga, I. (2022). Executive functions and improvement of thinking: An intervention program to enhance deductive reasoning abilities. *The Spanish Journal of Psychology*, *25*, e32. https://doi.org/10.1017/SJP.2022.26.

Hopfenbeck, T. N., Lenkeit, J., El Masri, Y., Cantrell, K., Ryan, J., & Baird, J. A. (2018). Lessons learned from pisa: A systematic review of peer-reviewed articles on the programme for international student assessment. *Scandinavian Journal of Educational Research*, *62*(3), 333–353. https://doi.org/10.1080/00313831.2016.1258726.

Gursoy, N. K., Senturk, I., Oner, T., & Gursoy, A. (2020). A new algorithmic decision for categorical syllogisms via Carroll's diagrams. *Soft Computing*, *24*(15), 11337–11346. https://doi.org/10.1007/s00500-019-04598-9.

O'Reilly, C., Devitt, A., & Hayes, N. (2022). Critical thinking in the preschool classroom - A systematic literature review. *Thinking Skills and Creativity*, *46*, 101110. https://doi.org/10.1016/j.tsc.2022.101110.

Pfeifer, N., & Sanfilippo, G. (2023). Probability propagation rules for Aristotelian syllogisms. *Annals of Pure and Applied Logic*, *175*(9), 103340. https://doi.org/10.1016/j.apal.2023.103340.

PISA. (2023). *PISA 2022 results factsheets Indonesia PUBE*. Oecdch. https://oecdch.art/a40de1dbaf/C108.

Pithers, R. T., & Soden, R. (2000). Critical thinking in education: A review. *Educational Research 42*(3), 237-249. https://doi.org/10.1080/001318800440579.

Riesterer, N., Brand, D., Dames, H., & Ragni, M. (2020). Modeling human syllogistic reasoning: The role of "no valid conclusion." *Topics in Cognitive Science*, *12*(1), 446–459. https://doi.org/10.1111/tops.12487.

Senturk, I., Gursoy, N. K., Oner, T., & Gursoy, A. (2021). A novel algorithmic construction for deductions of categorical polysyllogisms by Carroll's diagrams. *Information Sciences*, *578*, 236–256. https://doi.org/10.1016/j.ins.2021.07.029.

Sethy, S. S. (2021). *Introduction to logic and logical discourse*. Springer Nature.

Stovall, P. (2021). Syllogistic reasoning as a ground for the content of judgment: A line of thought from kant through hegel to peirce. *European Journal of Philosophy*, *29*(4), 864–886. https://doi.org/10.1111/ejop.12609.

Tessler, M. H., Tenenbaum, J. B., & Goodman, N. D. (2022). Logic, probability, and pragmatics in syllogistic reasoning. *Topics in Cognitive Science*, *14*(3), 574–601. https://doi.org/10.1111/tops.12593.

Tiatri, S., Beng, J. T., Fiscarina, C., & Dinata, H. (2020, December). Challenges in developing literacy learning models for teachers to develop cognitive strategies for elementary school students. In *The 2nd Tarumanagara International Conference on the Applications of Social Sciences and Humanities (TICASH 2020)* (pp. 754-758). Atlantis Press.

Tiatri, S., Ie, M., Hussy, C., Bagus, I., Tirtha, A. V., Teresa, L., Natan, T., Tanoto, M., Rindarningsi,Y., Jap, &, & Beng, T. (2023). Development of the critical thinking categorical syllogism learning model in elementary students. *International Journal of Application on Social Science and Humanities*, *1*(3), 1–8. https://doi.org/10.24912/ijassh.v1i3.27015.

Tiatri, S., & Tji Beng, J. (2015). Preliminary investigation on the effectiveness of a thinking skill training in Indonesia: "Thinking skills training with digital technology." *Journal of Psychological and Educational Research JPER, 23*(2).

Tiatri, S., Veronica, C., Fiscarina, C., Nurkholiza, R., Wakano, V. Y., Ie, M., & Beng, J. T. (2023). Elementary school teachers' perceptions of critical thinking in stem learning. *International Journal of Application on Social Science and Humanities*, *1*(1), 648–658. https://doi.org/10.24912/ijassh.v1i1.25924.

Awalianti, A. (2024, January 1). *Two southeast asian nations attain top 35 highest pisa scores worldwide*. Seasia. Retrieved April 29, 2024, from https://seasia.co/2024/01/01/two-southeast-asian-countries-seize-the-worlds-35-highest-pisa-scores

Van Rooij, R., & Xie, K. (2020). A causal analysis of modal syllogisms. In *Monotonicity in Logic and Language: Second Tsinghua Interdisciplinary Workshop on Logic, Language and Meaning, TLLM 2020, Beijing, China, December 17-20, 2020, Proceedings 2* (pp. 183-206). Springer Berlin Heidelberg.

Wasielewski, J., Rydzewska, K., & Sedek, G. (2021). Effects of depressed mood on syllogistic reasoning: The buffering role of high working memory span. *Frontiers in Psychology*, *12*, 645751. https://doi.org/10.3389/fpsyg.2021.645751.