



## Elementary Students' Logical-Thinking Ability and Its Relationship with Gender

Henni Riyanti<sup>1✉</sup> & Putri Dewi Nurhasana<sup>2</sup>

<sup>1✉</sup>Universitas PGRI Palembang, henniriyanti@univpgri-palembang.ac.id, Orcid ID:[0000-0002-7051-116X](https://orcid.org/0000-0002-7051-116X)

<sup>2</sup>Universitas PGRI Palembang, putridewi.nurhasana@univpgri-palembang.ac.id,  
Orcid ID: [0000-0001-8793-9800](https://orcid.org/0000-0001-8793-9800)

### Article Info

#### History of Article

Received:  
27 March 2022  
Revised:  
25 April 2022  
Published:  
30 April 2022

### Abstract

Logical-thinking ability is one of the 21st-century competencies that plays an important role in an individual's ability to be responsive in acting and making decisions to solve societal problems. However, logical-thinking ability can differ due to several factors, one of which is gender. Therefore, this research aimed to identify the relationship between elementary school students' logical-thinking ability and gender. One hundred forty-nine students from 5 different elementary schools in Surakarta City, Indonesia, were involved in this research. The research subjects were taken by random sampling technique. The data were tested using the validity and reliability tests of logical thinking, which were then analyzed using a quantitative descriptive technique on SPSS 22 software with the Pearson Correlation test. The results showed a significant relationship between logical-thinking ability and gender, as seen from the correlation value of the Pearson Correlation test of 0.210 and Sig. of  $0.01 < 0.05$ . Hence, logical-thinking ability is strongly connected with gender. The result showed that the female students' logical-thinking ability was better than male students. These results can be considered for educators to design appropriate learning to develop logical thinking skills for both male and female students.

### Keywords:

Logical Thinking Ability, Gender, Cognitive Style

### How to cite:

Riyanti, H., & Nurhasana, P. D. (2022). Elementary students' logical-thinking ability and its relationship with gender. *EduBasic Journal: Jurnal Pendidikan Dasar*, 4(1), 97-104.

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**Info Artikel***Riwayat Artikel*

Diterima:  
27 Maret 2022  
Direvisi:  
25 April 2022  
Diterbitkan:  
30 April 2022

**Abstrak**

Kemampuan berpikir logis merupakan salah satu kompetensi abad 21 yang berperan penting dalam kemampuan individu untuk tanggap dalam bertindak dan mengambil keputusan untuk memecahkan masalah masyarakat. Namun kemampuan berpikir logis dapat berbeda satu sama lain karena beberapa faktor, salah satunya adalah jenis kelamin. Oleh karena itu, penelitian ini bertujuan untuk mengidentifikasi hubungan antara kemampuan berpikir logis siswa sekolah dasar dengan jenis kelamin. Penelitian ini melibatkan 149 siswa dari 5 Sekolah Dasar yang berbeda di Kota Surakarta, Indonesia. Subyek penelitian diambil dengan teknik random sampling. Data diuji dengan menggunakan uji validitas dan uji reliabilitas berpikir logis, yang kemudian dianalisis menggunakan teknik deskriptif kuantitatif pada software SPSS 22 dengan uji Korelasi Pearson. Hasil penelitian menunjukkan bahwa terdapat hubungan yang signifikan antara kemampuan berpikir logis dengan jenis kelamin dilihat dari nilai korelasi uji Pearson Correlation sebesar 0,210 dan Sig. dari  $0,01 < 0,05$ . Oleh karena itu, kemampuan berpikir logis sangat terkait dengan gender. Hasil penelitian menunjukkan bahwa kemampuan berpikir logis siswa perempuan lebih baik daripada siswa laki-laki. Hasil tersebut kemudian dapat menjadi bahan pertimbangan bagi pendidik untuk merancang pembelajaran yang tepat agar pendidik dapat mengembangkan kemampuan berpikir logis baik bagi siswa laki-laki maupun perempuan.

**Kata Kunci:**

Kemampuan Berpikir Logis, Jenis Kelamin, Gaya Kognitif

**Cara Mensitasi:**

Riyanti, H., & Nurhasana, P. D. (2022). Elementary students' logical-thinking ability and its relationship with gender. *EduBasic Journal: Jurnal Pendidikan Dasar*, 4(1), 97-104.

## INTRODUCTION

Logical-thinking skill is one of the 21<sup>st</sup>-century skills that need to be developed. One of the goals of science learning is to create logical-thinking skills (Parmin et al., 2017). It is the ability to draw conclusions based on cognitive knowledge to solve a problem through a series of abstractions and generalizations (Pezzuti et al., 2014; Seyhan, 2015). The advancement of science and technology in the 21<sup>st</sup> century requires individuals who can produce solutions to existing complex problems. The solution to such complex issues can be generated by individuals who have logical-thinking skills (Maharani & Laelasari, 2017). The roles of logical thinking, among others, are as follows: (1) to help and understand objective things correctly; (2) to identify and correct errors logically; (3) to help learn knowledge more deeply; (4) to express ideas accurately (Liu, 2013).

There are some experts' opinions that define logical-thinking ability. Tobin and Capie (1981) assessed logical-thinking ability through the Test of Logical Thinking (TOLT), which included five components: controlling variables, proportional reasoning, probabilistic reasoning, correlational reasoning, and combinatorial reasoning (Nurismawati et al., 2018). The following expert defines logical-thinking ability as estimating probabilities, correlations, combinatorial calculations, and analogies to analyze, classify, prove, and synthesize a case (Sumarmo et al., 2012). Michael S. Stevens (in Raiyn, 2016) also stated that logical-thinking ability is one's ability to sort, compare, contrast, evaluate, and select to solve a problem. It can be assessed using written tests or observations of problem-solving activities using the indicators of achievement measurement of logical thinking.

Decision-making to solve a problem is predicted by cognitive style and mindset. This relationship is mediated by logical thinking (Riyanti & Nurhasana, 2021). The logical-thinking ability of each individual is different depending on several aspects, one of which is gender. Some research results show that gender affects scientific knowledge production, beliefs in making decisions, cognitive ability levels, and student interests

and choices that will impact the mindset of an individual (Wang & Degol, 2017). The discussion in this article focused on analyzing logical-thinking ability and identifying the relationship between logical-thinking ability and gender in Surakarta City, Indonesia.

The logical-thinking process concerns the cognitive developmental theory described by Jean Piaget. Piaget (in Ningrum, 2017) explained that one's cognitive development consists of four stages: sensory-motor, pre-operational, concrete, and formal stages. In the formal stage, an individual can reason with abstract images and expressions. At this stage, students have been intellectually mature and able to solve problems based on systematic experimentation. Based on Siswanto & Ratiningsih's (2020) research results, there is a link between formal thinking and the integrating process in logical thinking, such as identifying, controlling, and making hypotheses.

There is a close relationship between logical thinking and cognitive style. The more they use logical thinking, the better their ability to maintain cognitive style will be (Pascual-Leone in Larivée et al., 2000). Some research revealed that adults overcome their daily problems by applying the experience to think logically and using their cognitive style to support the formation of solutions (Greiff et al., 2013).

Gender plays a vital role in one's logical-thinking ability. Differences in cognitive-ability level, student interests, and choices between men and women affect logical-thinking ability. Several pieces of research have shown that women get better grades than men in mathematical logic, biology, and motivation in writing tasks (Voyer & Voyer, 2014). The research conducted by Jones et al. (2000) and Shubina & Kulakli (2019) also explained that women prefer to learn about matters relating to nature; men prefer learning about computers, electricity, and cars. Gender effects on the differences in the levels of cognitive ability and students' interests and choices can have an impact and relationship to an individual's logical-thinking ability.

Based on this background, knowing the relationship between students' logical thinking ability and gender is essential. Therefore, this research aims to determine elementary school

students' logical-thinking ability in Surakarta, Indonesia, and to identify the relationship between logical-thinking ability and gender. The research results obtained then can be used as a basis for an educator to determine the characteristics of the students being taught. So that they can design and develop appropriate learning designs for each student to optimize their logical thinking ability. It is essential to consider that logical-thinking ability plays an important role in an individual's ability to be responsive in acting and making decisions to solve societal problems. Therefore, this study draws the title Elementary Students' Logical-Thinking Ability and Its Relationship with Gender.

## METHODS

This correlation research aims to determine the relationship between the two variables determined, namely logical-thinking ability and gender. The data collection of students' logical-thinking skills was conducted using a multiple-choice test with five alternative answer choices. The logical-thinking test instrument refers to the concept of natural science learning.

The test instrument consisted of 25 multiple-choice items referring to the five components of logical-thinking ability according to *How to Be a Better Problem Solver* by Michael S. Stevens: ordering, comparing, contrasting, evaluating, and selecting. After the test items were tested, there were 20 valid and reliable items with the item distributions as follows: items 1-4 were ordering aspect; items 5-9 were comparing aspect; items 10-15 were contrasting aspect; items 16-18 were evaluating aspect; and items 19-20 were selecting aspect.

The sample selection was made by random sampling technique. The sample used in this research consisted of 149 ninth-grade students from 5 different elementary schools in Surakarta, Central Java, Indonesia. The sample distribution can be seen in the following table.

**Table 1.** Sample Distributions

Educational Units	Gender		Total
	Male	Female	
1	10	21	31
2	9	20	29
3	11	18	29
4	10	19	29
5	12	19	31
Total	52	97	149

The results of the logical-thinking ability test were then analyzed descriptively-quantitatively using SPSS 22 software with Pearson Correlation to determine the students' logical-thinking abilities and identify the relationship between logical thinking and gender.

## RESULTS AND DISCUSSION

The students' logical-thinking abilities were assessed based on the number of correct answers to the 20 test items in multiple choices. The students got a score of one (1) for each item answered correctly and zero (0) for each wrong answer. Those who earned an average score of 70% or higher (14 or more correct answers) were assumed to have sufficient logical-thinking ability.

**Table 2.** The Students' Logical-Thinking Abilities on the Concept of Natural Science Learning

Correct Answer	Score Range (%)	Number of Students		Conclusion
		Male	Female	
18-20	85-100	1 (2%)	0 (0%)	Sufficient
14-17	70-84	8 (16%)	30 (31%)	Sufficient
11-13	55-69	21 (40%)	43 (44%)	Insufficient
10 or less	54 or less	22 (42%)	24 (25%)	Insufficient
Mean = 11.89		St.Dev = 2.76		

The results shown in Table 2 explain that 18% of male and 31% of female students have sufficient logical-thinking abilities in natural science learning. The mean score of the students' logical thinking on the concept of

natural science learning was 11.89, with a standard deviation of 2.76.

**Table 3.** The Percentages of the Students' Correct Answers on the Test of Logical-Thinking Skill

Logical-Thinking	Item	Mean	Correct Answers (%)	Average Score
Ordering	1	0.75	75	79.25
	2	0.74	74	
	3	0.81	81	
	4	0.87	87	
Comparing	5	0.40	40	52.8
	6	0.57	57	
	7	0.87	87	
	8	0.10	10	
	9	0.70	70	
Contrasting	10	0.35	35	56
	11	0.72	72	
	12	0.54	54	
	13	0.87	87	
	14	0.41	41	
	15	0.47	47	
Evaluating	16	0.36	36	56.67
	27	0.54	54	
	18	0.80	80	
Selecting	19	0.49	49	52
	20	0.55	55	
Total		11.89		59.34

Table 3 shows that the average student score who answered the questions of logical-thinking ability on the concept of natural science learning was mainly on the ordering indicator, which equals 79.25. It was followed by evaluating (56.67), contrasting (56), and comparing (52.8). The average lowest score of the correct answers was on the indicator of selecting (52). Table 3 also shows that the average score of the students' correct answers is 59.34.

### The Relationship between Logical-Thinking Ability and Gender

This research identified the relationship between logical-thinking ability and gender by calculating Pearson correlation using SPSS 22 software with the trust level  $\alpha = 0.05$ .

**Table 4.** The Correlation between Logical Thinking and Gender

Gender	Gender Values	
	Pearson Correlation	1
Gender	Sig. (2-tailed)	.210*
	N	149
Logical-Thinking Ability	Pearson Correlation	.210*
	Sig. (2-tailed)	.010
	N	149

\*. The correlation is significant at the 0.05 level (2-tailed).

Table 4 shows that the correlation value of Pearson produced is 0.210. These results indicated a significant relationship between logical-thinking ability and gender, with the trust level  $\alpha = 0.05$  (5%). Based on Table 4, it was known that the Sig value between Gender (X1) and logical-thinking ability (X2) was  $0.01 < 0.05$ , which means there was a significant relationship between the two variables (Ghozali in Hermutaqien, 2021).

### Discussion

This research aims to determine elementary school students' logical-thinking ability in Surakarta, Indonesia, and to identify the relationship between logical-thinking ability and gender. The results showed that the average score of the logical-thinking ability of elementary school students in Surakarta was 59.34. The average score for each indicator of logical thinking was ordering (79.25), comparing (52.8), contrasting (56), evaluating (56.67), and selecting (52). The identification of the relationship between logical-thinking ability and gender showed a significant relationship between the two variables with a correlation value of Pearson (0.210) and Sig. (0.01).

The average value of logical-thinking ability of 59.34 indicated that the logical-thinking ability of elementary school students in Surakarta was still low. Some of the reasons that support the research results were obtained from the interviews with students and teachers. Supporting data were also obtained from the documentation of the teachers' lesson-planning instruments during the learning process.

The interviews with some students indicated that the classroom learning process

was still focused on the teacher. The teacher often delivered the lesson material using the lecturing method and did not present the latest phenomena related to the materials being studied. The presentation of problems requiring logical interpretation will support the empowerment of students' logical thinking and problem-solving (Seyhan, 2015). It is in line with the interview results of some school teachers. The respondents stated that the students who were challenged to be conditioned and the long enough time of learning models became the factors that they rarely did the lab or applied the learning models in the classroom. 21<sup>st</sup>-century learning should be student-centered. The delivery of materials is integrated with the student's day-to-day context and collaborative education so that students have the confidence to develop their abilities (Velmurugan & Saranya, 2017).

Table 3 shows that the average score of the students who answered the questions of logical-thinking ability on the concept of natural science learning was mainly on the ordering indicator, with a score of 79.25. The interviews with the students indicated that they were used to finding the characteristics of making a sequence in other subjects. It helped them answer the questions requiring the ability to sort. Based on the observation of the learning-evaluation instruments, the test items the teachers used to evaluate learning have not been able to support the empowerment of the students' logical-thinking abilities.

The effects generated from gender have an essential role in logical-thinking ability. The identification of the relationship between logical-thinking ability and gender (Table 4) showed a significant relationship between the two variables with the correlation value of Pearson of 0.210 and Sig. of 0.01. Gender differences result in differences in the student's interests and choices and impact an individual's thinking ability to make decisions (Gullberg et al., 2017). Table 2 presented that 31% of female students have sufficient logical-thinking ability. The percentage was higher than the male students, who only achieved 18%. It indicated that female students have better logical-thinking abilities than male students. Gender differences are an example of genetic predisposition and are associated with sociocultural factors resulting in different

outcomes. In line with that, Wang & Degol (2017) also explained that students' interests in education and career would influence the decision-making in the lesson and the selection of activities that will enhance and develop the careers they are interested in.

Based on the results obtained, it can also be seen that the logical thinking abilities of male and female elementary school students have differences. The logical thinking ability of female students is higher than that of male students. Based on Table 2, as many as 31% of female students have sufficient logical-thinking ability, while the male students are only 18%. These results can be considered for educators to design appropriate learning to develop logical thinking skills for both male and female students.

## CONCLUSION

The results showed a significant relationship between logical-thinking ability and gender, as seen from the correlation value of Pearson of 0.210 and Sig. of  $0.01 < 0.05$ . Hence, Logical-thinking ability had a strong relationship with gender. The female students' logical-thinking ability was better than the male students. The research results obtained then can be used as a basis for an educator to determine the characteristics of the students being taught. So that they can design and develop appropriate learning designs for each student to optimize their logical thinking ability. Further research can investigate the same area, mainly to create solutions that can be used to optimize both female and male students' logical-thinking abilities

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