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The Effect of the Mathematıcs Course Taught wıth Logıcal Reasonıng Methods on the Success of Students in Skıll-Based Questıons and Student Opınıons on Teachıng

Esra Altintas[✉1] **& Meltem Angay**[2]

[1] Mathematics education department, Aydın Adnan Menderes University, Turkey
[2] Teacher of Mathematics at National Ministry of Education, Turkey

✉ esra.altintas@adu.edu.tr

Abstract. Does the mathematics course taught with logical reasoning methods have an effect on the success of students in skill-based questions and what are the students' views on teaching? Based on this problem, it was aimed to examine the effect of the mathematics course taught with logical reasoning methods on the success of students in skill-based questions and to examine students' opinions. In the study group, a total of 35 students, 18 of whom were in the experimental group and 17 of them in the control group, were studied with 7th grade students. Since qualitative and quantitative data are used together, the method of the research is mixed method research. The results of the research show that students' use of reasoning methods in the teaching process increases the success in skill-based questions. When the opinions of the experimental group students were examined, it was concluded that in the lessons taught using logical reasoning methods, they reached the rules themselves, that they were fun, that skill-based questions were difficult, but there was a change in these thoughts at the end of the research.

Keywords: Deduction, Geometry Teaching, Induction, Logical Reasoning, Skill-Based Questions.

1. Introductian

The definition of mathematics varies according to people's occupations and interests. For example, according to some people it is a game of intelligence, for some it is a science that deals with abstract objects such as numbers, for some it is a necessary calculation technique in our practical life. According to mathematicians, it is the whole of thought systems that lead people to the absolute and absolute truth (Yıldırım, 2020). Thinking is transformed into reasoning, which is a more systematic form by training (Duran, 2019). Reasoning has two purposes. These; It is to obtain new information that was not known before, based on known information, and to prove whether the existing information is correct (İmamoğlugil, 2018). In mathematics, reasoning is considered as a process in which some inferences are made with predictions or proofs (Cokyaşa, 2019). In reasoning-based mathematics teaching environments, students reach a conclusion by thinking logically, so they become more confident in the course (Erdem, 2022). The Ministry of National Education (MEB, 2018) has explained some of the aims that should be given to students with the mathematics course in the mathematics curriculum as follows. "*In the problem solving process, they will be able to easily express their own thoughts and reasoning, and will be able to see the deficiencies or gaps in the mathematical reasoning of others. Will be able to use mathematical terminology and language correctly to explain and share mathematical thoughts in a logical way.*" As it can be understood from here, reasoning is an important skill that should be acquired both in arranging one's own mind and thoughts and in solving problems. Reasoning-based teaching of mathematics should be made especially for students who have mathematics anxiety (Erdem, 2022).

1.1. Problem Statement

The most qualified education system is the system in which thinking is trained. It should be the most necessary acquisition of the education system for students to think and understand correctly and to convey what they understand (Çelik, 2021). Especially reasoning skill is very important for the development of other mathematical skills (Zaini & Retnawati, 2019). Reasoning skill is a skill used to determine ways and methods by thinking logically and systematically while solving problems in non-routine situations (Mullis & Martin, 2017, as cited in Ministry of National Education (MEB), 2020). Reasoning (reasoning) enables the problem to be handled and solved as a whole by incorporating past experiences into the problem solving process (Arpacı, 2022). Reasoning is a very important skill for math class. Students should be able to use their minds to arrive at a conclusion and reach logical conclusions. But this is a complex process for students. Looking at the studies, a general low level of success in reasoning questions is observed (Zaini & Retnawati, 2019). It is necessary to teach logic principles and reasoning methods in order to support and develop students' reasoning skills (Can et al., 2019). The Ministry of National Education (MEB) switched to the High School Entrance Examination (LGS) system, in order to improve students' high-level thinking skills such as reasoning, association, and hypothetical thinking, and to be more effective in international exams, and the International Student Assessment Program (PISA) and International Mathematics and Science Tendency Survey (TIMSS) has started to ask questions that need to be solved by reasoning and analysis of information (Arpacı, 2022). TIMSS, which was established to measure and evaluate the achievements of countries in the fields of mathematics and science in four-year periods, determined the middle point of the success reference as 500 points. Although Turkey has increased its scores every year, it remains either below the midpoint of the scale or at a moderate level. In the TIMSS 2019 report, it was stated that fourth grade students performed the lowest in reasoning in mathematics. On the other hand, it was observed that the lowest performance of the eighth graders in the field of mathematics was the field of algebra and geometry (MEB, 2020). Based on the information given above, an answer will be sought for the following problem:

Does the mathematics course taught with logical reasoning methods have an effect on the success of students in skill-based questions and what are the students' views on teaching?

The increase in success to be achieved in skill-based questions in the mathematics course will increase the success to be obtained in international exams with LGS, which uses such questions. In the research, students' success in skill-based questions that require high-level thinking skills such as reasoning skills will be investigated depending on the logical reasoning methods used in teaching the subject, revealing their effectiveness, and contributing to the teaching method will guide the teachers.

Sub Problems:

1. Is there a statistically significant difference between the pre-test scores of the experimental and control groups before the application?

2. After the application, is there a statistically significant difference between the pre-test and post-test scores of the experimental group?

3. After the application, is there a statistically significant difference between the pre-test and post-test scores of the control group?

4. After the application, is there a statistically significant difference between the post-test scores of the experimental and control groups?

5. What are the opinions of the experimental group students about the lesson taught with logical reasoning?

1.2. Related Research

Researches on reasoning have shown that students' learning mathematics with different teaching methods such as enriched learning environments and interactive multimedia tools improves some mathematical skills, especially reasoning skills (Amir et al., 2018; Dodeen et al., 2012; Erdem, 2015; Kızıltoprak, 2020; Sahara and Harton, 2015; Tum, 2019; Üstün, 2019). Reasoning and problem solving are interrelated, and it is very important to gain both skills (Budayasa & Juniati, 2018). Considering the studies, it was seen that the reasoning skills and strategies that should be used in non-routine problems are insufficient (Arifanti, 2020; Arslan, 2007; Sinambala, 2019; Yeo, 2009; Zaini and Retnawati, 2019). The development of students' reasoning skills depends on the curriculum applied in schools and the strategies used by students in the teaching process. In addition, it is a result of studies that teacher-student interaction is effective on students' reasoning skills (Altıparmak & Öziş, 2005; Can et al., 2019; Kim & Pegg, 2019; Wijaya et al., 2015). In the studies on skill-based questions, teachers stated that such questions are important for the development of students, but they are difficult for students, they cause students with low academic achievement to feel the feeling of failure more intensely when they encounter skill-based questions, and they do not use them in the lesson because the questions are long and time-consuming. (Karakeçe, 2021; Uzun, 2021; Ünsal and Kaba, 2021).

Considering the studies conducted with logical reasoning methods, it is seen that there are many mathematical reasoning fields such as probabilistic, geometric, algebraic, which are different types of reasoning in our country, but logical reasoning methods (deductive, inductive and analogical), which are the basis of the whole reasoning system, are studied in mathematics education. It has been found that there are not enough studies. With this research, 7th grade students who stepped into the abstract thinking period were taught mathematics by enabling them to use the most basic thinking and reasoning methods. Thus, the reasoning skill that should be used in skill-based questions started to be used while learning the subject. The contribution of such a study to mathematics educators and the literature will be significant.

1.3. Research Objectives

The aim of this research is to examine the effects of the lessons taught with logical reasoning methods on the success of the students in skill-based questions by teaching the subjects related to the "Polygons" sub-learning area of Mathematics according to the lesson plan prepared with logical reasoning methods.

2. Theoretical Framework

A person is a creature that constantly thinks and activates his logical systems while he is thinking, except in the state of sleep. People aimed for consistency in thought by applying logic in thought (Karakullukçu, 2007). "Logos", which corresponds to the Greek word for logic, means thinking based on reason, which is used to understand the universe scientifically and systematically. According to Islamic logicians, logic is derived from the word 'nutk' and it is the power of people to make sense of the universe, the thought or inner speech that occurs with this power, and the adventure of expressing these thoughts (Çüçen, 2021). Logic is not just a science, people who do not read the science of logic can also be logical by thinking correctly and properly. Logic, which is also used in daily life, means consistent or neat thinking (Çüçen, 2021). Logic studies a certain thinking and is based on certain principles. Identity, non-contradiction and the impossibility of the third option are among these logic principles (Akçagün, 2019). According to Aristotle, the principles of the mind are also the principles of existence and its source is innately ready in the human mind (Çüçen, 2021).

Logical thinking begins at an early age. In Piaget's sensory-motor stage (0-2 years of age), infants begin to establish a cause-effect relationship by observing their environment with their sense organs. In the later preoperational period (2-7 years), children's language development is at the forefront and their logical thinking skills continue to develop, but reasoning cannot be

done. In the concrete operational period (7-11 years), it is a period in which the objects in the environment are started to be processed with the symbols developed in the mind, logical results are reached and deductive reasoning can be carried out. In the abstract operations period (11-18 years), it is a period in which the transition from concrete reality to abstract operations is experienced. Cognitive explorations are made with hypothetical reasoning (Başerer, 2019).

Mathematics tries to prove some properties of numbers or shapes (arithmetic, algebra and geometry) by revealing them (Çüçen, 2021). Mathematics examines the relationships between abstract objects such as numbers and point sets. A two-stage method was used while doing mathematics. In the first, mathematicians revealed the relationship or feature between abstract objects, and secondly, they tried to prove the features or relationships they discovered (Yıldırım, 2020). Since the 17th century, the use of mathematics in sciences has increased and there has been an effort for mathematization in many sciences. The fact that the subject of mathematics is conceptual rather than factual is the most important feature that distinguishes mathematics from other sciences. For example; We cannot see numbers like other objects found in nature. In nature, countable objects are seen, not numbers. Numbers are a concept formed in the human mind during the counting process. For this reason, it seems more appropriate to classify mathematics not with empirical (factual) sciences, but with logic, which is a descriptive or formal (formal) discipline (Yıldırım, 2020).

It is very important to conceptualize abstract objects by making abstraction in the mind's acquisition of knowledge or in the development of human cognition (Çüçen & Ertürk, 2008). In this respect, logic and mathematics are similar to each other because they symbolized certain and correct inferences and presented them by developing their own proof (Çüçen, 2021). There are issues that cause students to be weak in reasoning. For example, students cannot express their thoughts. Especially low-achieving students lack confidence and doubt while expressing their thoughts (Arifanti, 2020). The complexity experienced during learning mathematics also manifests itself in mathematical reasoning (Çiftçi & Akgün, 2021).

Reasoning is valid for propositions that contain a proven-proving relationship. Logic, on the other hand, examines the relationship between evidence and what is proven. Whether propositions are true or false is not a matter of logic. In other words, logic is concerned with whether the conclusion will emerge from the chosen premises and the form of reasoning (İmamoğlugil, 2018). Reasoning works with logical thinking. Logical thinking is thinking according to a measure (Arifanti, 2020). Approaching mathematics with questions of why and how in the teaching process contributes to students' high-level thinking skills (Erdem, 2022).

In classical logic, reasoning is handled in two ways as direct reasoning and indirect reasoning. If a conclusion is drawn from a single proposition, it is direct reasoning. If the reasoning is based on more than one proposition, it is indirect reasoning. There are three forms of indirect reasoning. These are deduction, induction and analogy (İmamoğlugil, 2018).

Deduction is based on the principle that "what is true for the whole is also true for its parts". Since there is a flow of thought from the general to the general or from the general to the specific in deductive reasoning, the fact that the general is true necessitates the particular to be true (İmamoğlugil, 2018). All inferences valid in logic are obtained by deductive reasoning. The other two reasoning methods are not necessarily always valid (Çüçen, 2021).

Inductive reasoning works in the opposite way of deductive reasoning. That is, in induction, there is a thinking from example to rule, from particular to general. The conclusion reached in induction has a scope that goes beyond the premises. In other words, the conclusion is not limited to the premises, but takes them further (İmamoğlugil, 2018). In induction, reason infers from the particular to the universal, from the part to the whole, from the particular to the general. The result reached here was obtained by hypothetical generalization (Çüçen, 2021).

Analogy is reasoning based on similar events and objects based on events and objects (İmamoğlugil, 2018). Analogy is the process of revealing unknown similarities based on seen

and known similarities (Emiroğlu, 2004, cited by İmamoğlugil, 2018). Analogical reasoning is the first step in acquiring new knowledge. In other words, classification is made in the mind based on the common features of objects and events. In this way, the mind reaches what it does not know from what it knows (Çelik, 2021).

Eliminating the gap between the mathematical knowledge learned at school and real life is an effort aimed at teaching mathematics. The use of mathematical information in real life situations is expressed as mathematical literacy (Altun & Bozkurt, 2017). Mathematical literacy is a skill that is desired to be measured especially in international exams (such as TIMSS, PISA). These exams measure students' ability to apply what they learned at school to real-life problems. International exams provide opportunities for countries to control, develop and improve their own education systems (Erden, 2020). In our country, there has been a change in the secondary education entrance exam in order to reach international standards, and the Transition Exam to High Schools (LGS) system has been replaced by the Basic Education Transition Exam (TEOG) in the 2017-2018 academic year (Karakeçe, 2021). With LGS, skill-based questions, also known as new generation questions, aiming to measure students' problem solving, reasoning, association and high-level thinking skills have been started to be used (Uzun, 2021).

3. Method

3.1. Research Design

The model of this research is a mixed method research in which qualitative and quantitative data are used together, since it aims to examine the effect of the mathematics course taught with logical reasoning methods on the success of students in skill-based questions and students' opinions. Mixed methods research is defined as a research in which qualitative and quantitative data, findings and analyzes of the data are discussed and different methods are used together in order to examine the research problem in a multidimensional way (Yıldırım & Şimşek, 2018). In this study, explanatory design, one of the mixed method research designs, was used. In descriptive pattern research, quantitative data is collected first, while qualitative data is collected to explain, support or exemplify quantitative data. In descriptive design studies, qualitative and quantitative data are collected separately, and the contributions of qualitative and quantitative data to the research are equal (Yıldırım & Şimşek, 2018).

Experimental design with pretest-posttest control group was used in the quantitative dimension of the study. One of the two groups formed in the experimental design with pretest-posttest control group is assigned as the experimental group and the other as the control group. Pre-test and post-test of the dependent variable are applied to the experimental and control groups, and the data of the groups are compared with appropriate statistical methods in order to see the effect in the experimental process (Büyüköztürk et al., 2016). In this study, the control and experimental groups were selected by looking at the pre-test results applied to the 7/A and 7/B branches formed from the 7th grade students in the school where the research was conducted. The 7/B branch with a lower pre-test average was determined as the experimental group, and the 7/A branch with a higher pre-test average than the 7/B branch was determined as the control group.

In the qualitative aspect of the research, the opinions of the students in the experimental group about the application were taken. In this study, case study, one of the qualitative research methods, was used. Qualitative research is a research in which qualitative data collection methods are used, involving different disciplines and concepts, and a qualitative process is followed to reveal perceptions and events in a natural environment in a realistic and holistic way. Case studies, on the other hand, are to reveal a result by conducting in-depth research about an individual, institution, group or environment (Yıldırım & Şimşek, 2018). In this study, the research was carried out with case study, one of the qualitative research methods, since it was desired to examine in depth how the mathematics course taught by applying logical reasoning methods had an effect on the students and the opinions of the students on the skill-based questions.

3.2. Population and Sample

This research was carried out with 7th grade students in an Imam Hatip Secondary School in the Ahlat district of Bitlis province in the second term of the 2021-2022 academic year. While the universe of the research consists of all 7th grade students in the Ahlat district of Bitlis province, the sample consists of 35 7th grade students studying at an Imam Hatip Secondary School in the same district. This school, where the researcher works, has a low average in terms of success in the High School Entrance Examination (LGS). The reason why 7th grade students were chosen in this study is that abstract thinking and inferential reasoning start at the age of 12-13 and it is thought that it would be healthier to conduct the research without worrying since they are not in the exam period. Since the researcher works in this school and participation in the research is based on volunteerism, appropriate sampling method was used. If the researcher creates the sample group he needs starting from the most accessible group in order to prevent time and labor loss, this is the appropriate sampling method (Büyüköztürk et al., 2016). 7/A branch represented the control group and 7/B branch represented the experimental group by drawing lots from the 7/A and 7/B branches. The table below shows the gender and number of students participating in the research.

Table 1. Information of the Students Participating in the Study

Gender	Girl	Male	Total
Experiment	11	7	18
Control	8	9	17

As seen in the table, the experimental group students consisted of a total of 18 students, 11 girls and 7 boys, and the control group students consisted of a total of 17 students, 8 girls and 9 boys.

3.3. Data Collection Tool

In order to collect quantitative data in the research, a pre-test and post-test were prepared based on the subject of polygons and included skill-based questions. In order to get the opinions of the students in the experimental group about the application, a semi-structured student opinion form was prepared.

3.3.1. Polygons Pre-test and Post-test

The pre-test prepared to measure the success levels of the students in the experimental and control groups in the skill-based questions on the subject of polygons before the application and the post-test prepared to measure the success levels in the skill-based questions on the subject of polygons after the application consists of 8 questions. All the questions in the pre-test consisting of skill-based questions were prepared from skill-based tests published on the official website of the Ministry of National Education General Directorate of Assessment, Evaluation and Examination Services (ödsgm). Since the students are likely to remember the questions in the pre-test, the questions in the pre-test were modified while creating the post-test. The questions in the post-test are parallel to the questions in the pre-test in terms of gain and difficulty.

Table 2. Distribution of Polygons Pre-Test and Post-Test Question Items According to Acquisitions

Gains	**Question items**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
M.7.3.2.1. Explain the side and angle properties	×	×						

of regular polygons.									
M.7.3.2.2. Determines the diagonals, interior and exterior angles of polygons, calculates the sum of the measures of interior and exterior angles.			×	×					
M.7.3.2.3. Recognizes rectangle, parallelogram, trapezoid and rhombus, determines angle properties.					×	×			
M.7.3.2.4. Creates area relations of rhombus and trapezoid, solves related problems.							×	×	

3.3.2. Student Opinion Form

This data collection tool, which aims to examine students' opinions against the lesson in which the subject of polygons is covered and skill-based questions, with the logical reasoning methods applied to the experimental group, was prepared in the form of a semi-structured form. It is thought that it is important to get students' opinions with a semi-structured form in terms of expressing their thoughts without limitations, rather than questions limited by predetermined variables. Below are the questions in the student opinion form.

1. What is the difference of the course in which we teach the subject of polygons from other courses? Describe the moments you enjoyed and the moments you didn't.
2. What are your thoughts on skill-based questions (next generation questions)? Please explain.
3. Did your thinking towards skill-based questions (next generation questions) change during the two-week course? If so, in what direction have there been any changes? Please explain.

3.4. Implementation Process

The lesson plan prepared for logical reasoning methods was applied to the experimental group students by the researcher for a total of 10 hours, 5 hours each week, during the two-week course. In this process, it was ensured that the students reached the rules or characteristics related to the subject with their own reasoning by using deductive, inductive and analogical reasoning methods, which are logical reasoning methods.

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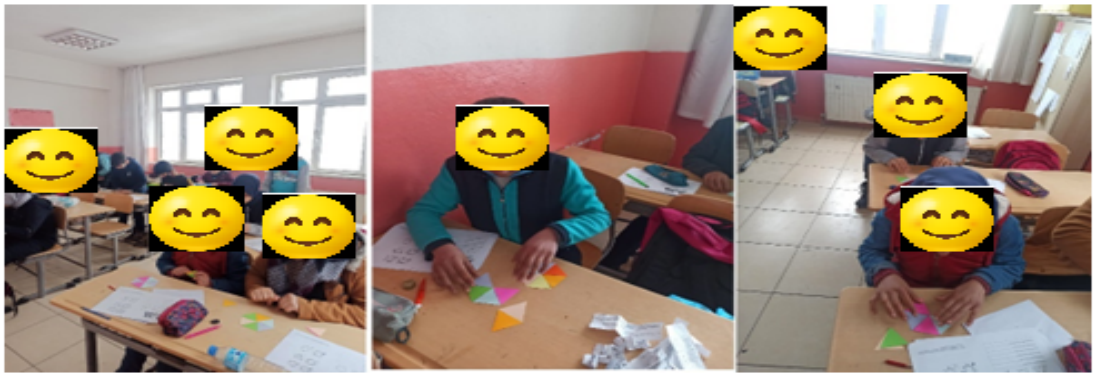
1. **Rectangle:**
   Definitions: 1. A parallelogram whose one angle measures 90 ° but whose adjacent sides are not of equal length **. 2.** A parallelogram whose diagonals are of equal length but do not intersect perpendicularly.

- Considering the rectangle definitions given above and the properties of the parallelogram, draw the shape of the rectangle and specify its properties below. (analogical reasoning)

  Properties:

  ……

A part of the lesson plan applied to the experimental group students is given above. With this teaching, the students were expected to reach the concepts, rules, shapes and properties of polygons and quadrilaterals belonging to the polygons sub-learning field by reasoning themselves.



Above, a visual is given from the teaching applied according to the logical reasoning methods with the experimental group students. The same subjects as the control group students were covered by the researcher with traditional methods. During the implementation process, a pre-test was applied to the experimental and control groups in the first week, then the experimental group students were taught the subject of polygons with logical reasoning methods for ten hours, and the same subjects were taught with traditional methods for ten hours with the control group students. The post-test was applied to the experimental and control groups in the fourth week of the application.

3.5. Validity and Reliability

After the pre-test and post-test to be used in the research were prepared, the validity of the tests was checked by taking the opinions of two academicians and two mathematics teachers. After the items took their final form, the pilot application part of the tests was started. For the pilot application, pre-test and post-test were solved separately for 27 8th grade students. Since the student group to be researched is at the 7th grade, the pilot application students were selected from the 8th grade. The purpose of the pilot application is to ensure that there are questions that are not understood in the tests created and that sufficient time is determined, thus increasing the validity of the tests. After the pilot application, it was decided that there was no unexplained problem and the duration was determined as 40 minutes. Afterwards, since the items in the posttest were changed, the Cronbach alpha internal consistency reliability coefficient was checked to measure the reliability of the posttest. As a result of the measurement, the Cronbach alpha coefficient was found to be 0.684. Since this value is between 0.60-0.80, it was determined that the post-test was quite reliable (Yıldız & Uzunsakal, 2018).

3.6. Data Analysis

In this research, which aims to examine the effect of the course taught with logical reasoning methods on the success of the students in skill-based questions and the students' opinions, firstly, a pre-test was applied to the experimental and control groups in order to investigate the effect of the applied method. It was checked whether the pre-test scores of the experimental and control groups showed normal distribution with the package program processed in the computer environment. Pre-tests, which were found to be normally distributed, were compared with the independent t-test, which is a parametric test and used to compare the means. After the lessons taught with the logical reasoning method, whose effect was tested, were applied to the experimental group and the lessons were taught with the existing methods without making any differentiation with the control group, the post-test was solved by both groups. In order to compare the pre-test and post-test mean scores of the experimental group and the control group, it was first tested whether the post-test scores had a normal distribution. It was understood that the post-tests of the experimental and control groups had normal distribution. The dependent t-test, which is one of the parametric tests, was used to compare the pre-test and post-test scores of the experimental and control groups separately. Finally, the independent t-test was used to compare the post-test scores of the experimental and control groups. In this way, quantitative data was analyzed.

Content analysis was used in the analysis of qualitative data. In the content analysis method, codes and categories are created based on the answers given to the questions. In this way, the data is analyzed by going deeper, the data is conceptualized and interpreted by coding (Yıldırım & Şimşek, 2018). The answers given in the opinion form applied in order to examine the opinions of the experimental group students about the application and against the skill-based questions were subjected to content analysis and divided into codes and categories. Using the Miles and Huberman model, the data were double coded and the agreement was found to be 0.92. In this way, the reliability of the research was ensured (Baltacı, 2017).

4. Findings

In this part of the research, the findings and interpretations of the pre-test and post-test, which are among the achievement tests applied to the experimental and control groups, which were formed with skill-based questions on polygons, were included. In addition, the findings and comments that were analyzed qualitatively and included the opinions of the experimental group were also included in this section.

4.1. Findings Regarding Pre-Test and Post-Test Normality Test

In order to analyze the data related to the pre-test and post-test applied to the experimental and control groups, it is necessary to decide which statistical methods will be applied first. For this, it should be checked whether the data show a normal distribution. In order to check whether the pre-test and post-test data applied to the experimental and control groups have normal distribution, since the group size is less than 50, the data were subjected to the normality test using the Shapiro-Wilk test. Tables of normality tests are given below.

Table 3. Control Group Pre-Test Shapiro-Wilk Normality Test Result

Values		Points
N		17
Values	$\overline{x}$	2.00
	ss	1.41
Shapiro-Wilk	Z	0.90
p		0.08

As seen in Table-3., as a result of the Shapiro-Wilk Test performed to control the normality of the distribution of the pre-test scores of the control group, it was determined that the distribution

did not differ significantly from the normal distribution (Z=0.90; p> 0.05). That is, the pre-test scores of the control group have a normal distribution.

Table 4. Experimental Group Pre-Test Shapiro-Wilk Normality Test Result

Values		Points
N		18
Values	$\overline{x}$	1.72
	ss	1.22
Shapiro-Wilk	Z	0.91
p		0.101

As seen in Table-4., as a result of the Shapiro-Wilk Test performed to control the normality of the distribution of the pre-test scores of the experimental group, it is understood that the distribution did not differ significantly from the normal distribution (Z=0.91; p> 0.05). Based on this, it is seen that the pre-test scores of the experimental group have a normal distribution.

Table 5. Control Group Post-Test Shapiro-Wilk Normality Test Result

Values		Points
N		17
Values	$\overline{x}$	2.76
	ss	1.14
Shapiro-Wilk	Z	0.89
p		0.055

As seen in Table-5., as a result of the Shapiro-Wilk Test performed to control the normality of the distribution of the post-test scores of the control group, it was determined that the distribution did not differ significantly from the normal distribution (Z=0.89; p> 0.05). This result shows that the post-test scores of the control group have a normal distribution.

Table 6. Experimental Group Post-Test Shapiro-Wilk Normality Test Result

Values		Points
N		18
Values	$\overline{x}$	4.05
	ss	2.15
Shapiro-Wilk	Z	0.89
p		0.056

As seen in Table-6., as a result of the Shapiro-Wilk Test performed to control the normality of the distribution of the post-test scores of the experimental group, it was determined that the distribution did not differ significantly from the normal distribution (Z=0.89; p> 0.05). With this result, it is understood that the post-test scores of the experimental group have a normal distribution.

4.2. Findings of the First Sub-Problem

Since the pre-test and post-test scores of the control and experimental groups have a normal distribution, parametric tests should be used in the tests to compare the means. First of all, the independent t-test was applied to compare the means of the pre-test scores of the control and experimental groups, and the table regarding the result is given below.

Table 7. Independent t-Test Results of Pre-Test Scores According to Experimental and Control Groups

	descriptive values				t-test		
Variables	n	$\overline{x}$	ss	sh	t	sd	p
Experiment	18	1.94	1.25	0.29	0.123	33	0.903
Control	17	2.00	1.41	0.34			

As seen in Table-7., the difference between the pre-test mean scores of the groups was not statistically significant as a result of the independent group t-test performed to determine whether the pre-test scores differed according to the experimental and control groups (t=0.123; p>0.05).). Based on this result, it is understood that the pre-test scores of the students in the experimental and control groups were similar.

4.3. Findings of the Second Sub-Problem

After the lesson was taught by applying logical reasoning methods with the experimental group, a post-test was administered to the students. The dependent t-test was conducted to see if there was a significant difference between the pre-test and post-test scores of the students, and the table regarding the result is given below.

Table 8. Dependent t-Test Results of the Experimental Group Pre-Test and Post-Test Scores

	descriptive values				t-test		
Variables	n	$\bar{x}$	ss	sh	t	sd	p
pretest	18	1.72	1.22	0.28	3.96	17	0.001
final test	18	4.05	2.15	0.50			

As seen in Table 8., the difference between the pre-test and post-test of the experimental group was statistically significant (t= 3.96; p<0.05). After the application was made to the experimental group students, there was an increase in their success scores in favor of the post-test. Based on this, it is understood that the course taught by applying logical reasoning methods has an important effect on increasing the success of students in skill-based questions.

4.4. Findings of the Third Sub-Problem

After the lesson was taught with the existing methods without making any differentiation with the control group, the post-test was applied to the students. The dependent t-test was applied to control the differentiation status between the pre-test and post-test scores of the students and the table regarding the results is given below.

Table 9. Dependent t-Test Results of the Control Group Pre-Test and Post-Test Scores

	descriptive values				t-test		
Variables	n	$\bar{x}$	ss	sh	t	sd	p
pretest	17	2.00	1.41	0.34	1.80	16	0.091
final test	17	2.76	1.14	0.27			

As seen in Table 9., the difference between the pre-test and post-test scores of the control group was not statistically significant (t= 1.80; p>0.05). It is understood that the course, which was taught with the control group students with the existing methods, did not have an effect on the success of the students in skill-based questions.

4.5. Findings of the Fourth Sub-Problem

In order to check whether there is a significant difference between the post-test mean scores of the experimental and control groups, the independent t-test was applied and the table regarding the results is given below.

Table 10. Independent t-Test Results of Post-Test Scores According to Experimental and Control Groups

	descriptive values				t-test		
Variables	n	$\bar{x}$	ss	sh	t	sd	p
Experiment	18	4.00	2.05	0.48	2.17	33	0.037
Control	17	2.76	1.14	0.27			

As seen in Table 10., the difference between the post-test mean scores of the experimental and control groups was statistically significant (t= 2.17; p<0.05). Considering the group averages, the difference between the averages is in favor of the experimental group (X=4.00). Based on this, it is understood that the students in the experimental group were more successful in the post-test than the students in the control group.

4.6. Findings of the Fifth Sub-Problem

After the two-week lesson, which was taught with the experimental group by applying logical reasoning methods, the students' opinions were taken in a semi-structured form. The answers of the students were examined and the answers were divided into categories and codes. The analyzes of the answers are given in the tables below.

Table 11. "What is the difference of the course in which we covered the subject of polygons from other courses? Explain the moments you enjoyed and the moments you did not." Percentage and Frequency Values Regarding the Distribution of the Answers to the Question by Categories and Codes

Category	Code	f	%
Differences	Not using a notebook	4	11.42
	Finding the rules themselves	7	20
	logic execution	one	2.85
positive aspects	easy to understand	2	5.71
	Quick to learn	one	2.85
	Increasing class participation	one	2.85
	Remembering the rules	one	2.85
	have fun	14	40
downsides	Few of the questions	one	2.85
	Sometimes it's hard	3	8.58

As seen in Table 11., "What is the difference of the course in which we teach the subject of polygons from other courses? Explain the moments you enjoyed and the moments you did not." The answers given to the question were examined and three categories were created. When the answers are examined, it is seen that the biggest difference of the lessons in which the subject of polygons is covered from the normal lessons is that the rules are found by the students (20%). Most of the positive opinions expressed by students about these courses are that they are fun (40%). It is seen that the number of students expressing positive opinions is higher. Sample student answers are given below.

- "The lessons in which we studied polygons allowed us to learn very differently and more quickly than other lessons." (T4)
- "It was very nice, I solved a lot of questions. I thought better myself and found it myself. I enjoyed it so much that I could understand better. I attended the math class more." (T7)
- "It was very nice, there were points where I got bored, there were very few questions why I was bored. The reason I had fun was because it was more fun than the regular class." (T13)
- "We used to write all the time in class, but in this class, we studied in a pleasant way without writing at all. It was fun to find the rule of thumb. Besides, I don't forget these rules because I came up with them myself." (T18)

Table 12. "What are your thoughts on skill-based questions (next generation questions)? Please explain." Percentage and Frequency Values Regarding the Distribution of the Answers to the Question by Categories and Codes

Category	Code	f	%
Positive	Good questions	4	11.76
	Solvability	5	14.70
	development	2	5.88
	Requires logic and knowledge	one	2.94
	hard to come	11th	32.35
	Requires more work	2	5.88

Negative	to be long	3	8.82
	Thinking you can't solve	3	8.82
	fear of questions	2	5.88
	hate questions	one	2.94

When Table 12., is examined, "What are your thoughts on skill-based questions (new generation questions)? Please explain." It is seen that two categories were created for the question. When the answers are examined, it is seen that the number of students who find skill-based questions difficult is higher (32.35%). It is seen that the reasons for the negative opinions about the skill-based questions are that the questions are long, require more effort, think that they cannot solve them, and are afraid of the questions. It is seen that students who expressed positive opinions were able to solve the questions and stated that there were questions that contributed to their development. Sample student answers are given below.

- "It is very difficult, I forget the root of the question while reading. I don't think I can solve it." (T7)
- "I think that by combining knowledge and logic, the solution of every problem can be reached much more easily. The questions are long but they make it so long just to intimidate. In fact, when you solve a lot of questions to be successful in long questions, the clue in the question is already very comfortable." (T12)
- "Actually, new generation questions used to be very difficult, but now I have changed my mind, it sounds moderate." (T16)
- "I hate new generation questions. Because I can't solve them. Likewise in experiments. They are very difficult questions." (T18).

Table 13. "Did your thinking towards skill-based questions (next-gen questions) change during the two-week course? If so, in what direction have there been any changes? Please explain." Percentage and Frequency Values Regarding the Distribution of the Answers to the Question by Categories and Codes

Category	Code	f	%
happened	Solving questions now	5	20.83
	Faster resolution	2	8.33
	be more understandable	3	12.5
	get more fun	3	12.5
	No longer afraid	4	16.66
	An increase in the desire to solve	3	12.5
It didn't happen	still hard to come by	4	16.66

As can be seen in Table 13., "Did your thoughts towards skill-based questions (new generation questions) change during the two-week course? If so, in what direction have there been any changes? Please explain." When the answers to the question were examined, two categories were created regarding the answers. It is seen that the majority of the students stated that the questions can now be solved (20.83%) and that there are positive changes in their thoughts. There are also students (16,66%) who stated that there was no change in their thoughts on skill-based questions and that the questions were still difficult. Sample student answers are given below.

- "The questions still come hard." (T15)
- "I am no longer afraid of new generation questions. It's not easy, but now I can understand. I can solve better. I almost understood the questions of mathematics." (T7)
- "I couldn't solve new generation questions. But such a method changed my perspective on these questions. Even though I still struggled a bit, it helped me solve it a little bit more easily." (T14)
- "Of course it did. When I saw the new generation questions, I was afraid, I thought I could not solve it, but now the new generation questions started to seem more fun to me. Desire to solve increased. Now that I saw them, I started to say "I can solve it"." (T18).

5. Discussion

The result of this research shows that students' use of reasoning methods in the teaching process increases the success in skill-based questions. Researches indicating that teaching by enriching the mathematics teaching process and contributing to students' reasoning skills improve students' reasoning and other mathematical skills (Amir, 2018; Kızıltoprak, 2020; Tum, 2019; Üstün, 2019), coincide with this result of our research. The result of this research also confirms Altıparmak and Öziş (2005), who stated that teaching the concepts by establishing cause-effect relationships in the teaching process and without memorizing the concepts is important in raising individuals who can look at problems from different angles. In our research, when logical reasoning methods are used in the learning process, students' success in skill-based questions that require reasoning and high-level thinking skills increases and the effectiveness of reasoning, which is a tool in problem solving (Albayrak Bahtiyari, 2010; Umay, 2003), has been proven by this research.

Another result of the research is that the course taught by applying traditional methods with the control group students has no effect on the success of the students in skill-based questions. In general, it has been stated that there is a general failure in problems or questions that require different skills and strategies, cannot be solved immediately and solutions require several stages (Arifanti, 2020; Arslan, 2007; Sinambela, 2019; Yeo, 2009). The results obtained with the control group students show this failure in skill-based questions. Zaini and Retnawati (2019), who stated that there was a general low level of success in questions that require reasoning, stated that teachers rarely do activities that improve students' reasoning skills, which is in line with the conclusion that traditional teaching has no effect on students' success in skill-based questions. Yeşildere and Türnüklü (2007) stated that teaching the lessons with traditional methods negatively affects mathematical skills, and it has been shown in this study that reasoning, which is an important purpose of mathematics education (MEB, 2018), therefore, success in skill-based questions that require reasoning cannot be gained by traditional teaching method.

While the experimental group students who attended the lesson taught with logical reasoning methods were more successful in skill-based questions, the control group students who taught with the traditional method showed lower success in skill-based questions. It has been stated that the development of other skills such as reasoning of students depends on the teaching process of teachers (Altıparmak & Öziş, 2005; Kim & Pegg, 2019; Wijaya et al., 2015). In this study, it has been seen that if the reasoning skills of the students are supported during the teaching process, the success in the skill-based questions that require reasoning will increase, and if the lessons are taught traditionally without any differentiation, the success of the students in the skill-based questions will not change in any way. Can et al. (2019) stated that logical principles and reasoning methods should be taught in order to improve students' reasoning skills, another result that overlaps with our research.

When the findings of the students' opinions in the experimental group were examined, the students stated that, unlike the other lessons, they found the rules themselves in the lessons on the subject of polygons and that it was fun and a few students (8.58%) sometimes had difficulties. This result coincides with the result of Seyhan (2003) that when students actively participate in teaching, both their success and positive views towards the lesson increase. Different activities offered in learning environments initiate the reasoning process in students (Çiftçi & Akgün, 2021), and when students reach some results by reasoning, meaningful teaching is provided and this process is fun for students.

When the findings of the question in which the students were asked their thoughts about the skill-based questions, it was seen that the students generally considered the skill-based questions difficult. The students who expressed negative opinions listed the reasons such as that the questions were long, more effort was needed, and that they were afraid of the question, thinking that they could not solve it. Some of the students expressed a positive opinion, saying that they could solve it and contributed to their development. Teachers, in general, find that skill-based questions are difficult and long, they do not have a lot of knowledge themselves (Karakeçe, 2021), they are not used in the lessons, considering the level of the students and the curriculum (Uzun, 2021), they contribute to the development of students but show low academic achievement. It is seen that the opinions of the students that they have the feeling of failure more (Ünsal & Kaba, 2021) coincide with the opinions of the students.

When the answers given to the question of whether there was any change in the thoughts of the students regarding the skill-based questions during the two-week course period were examined, it was seen that the opinions of the majority of them changed (83.34%), and that they were no longer afraid of the questions and that they could solve them. There are also students (16,66%) who stated that skill-based questions are still difficult. This result showed that when students use the skills that need to be used in the problem or question types they have difficulty in, the skills will develop and the thoughts towards the problems will change and they will become more self-confident, otherwise they will be insufficient in different reasoning when different problems are not encountered (Steen, 1999; Umay & Kaf, 2005). In addition, this result coincides with Erdem (2022)'s opinion that students are more self-confident and motivated in reasoning-based mathematics teaching.

In this study, since it was desired to measure success in skill-based questions, data collection tools were prepared as multiple choice and their analyzes were made only on the option they marked. It is thought that determining which logical reasoning methods (deductive, inductive and analogy) students use in the questions and detailed analysis of the answers can provide deeper information about the research.

6. Conclusion

When the pre-test and post-test averages of the experimental group students were examined, it was concluded that there was a significant difference in favor of the post-test. This result shows that teaching with logical reasoning methods has a significant effect on the success of the experimental group students in skill-based questions. When the pre-test and post-test averages of the control group were examined, it was concluded that the difference was not statistically significant. This result showed that the lesson, which was taught by applying traditional methods with the control group students, had no effect on the success of the students in skill-based questions. Considering the findings of the post-test averages applied to the experimental and control groups, the averages were found to be significant in favor of the experimental group. That is, the students in the experimental group who attended the lesson taught with logical reasoning methods were more successful in the skill-based questions, while the control group students who taught the lesson with the traditional method showed lower success in the skill-based questions. When the findings about the students' opinions are examined, it is seen that the biggest difference of the lessons in which the subject of polygons is covered from the normal lessons is that the rules are found by the students, that the majority of the positive opinions expressed by the students about these lessons are that the lessons are fun, and the number of students who express positive opinions is higher. Another result from the students' opinions is that the number of students who find skill-based questions difficult is higher. It is seen that the reasons for the negative opinions about the skill-based questions are that the questions are long, require more effort, think that they cannot solve them, and are afraid of the questions. It is seen that students who expressed positive opinions were able to solve the

questions and stated that there were questions that contributed to their development. At the end of the research, when the results of the students' thoughts towards skill-based questions are examined, it is seen that the majority of the students stated that the questions can now be solved and that there are positive changes in their thoughts. There are also students who stated that there was no change in their thoughts on skill-based questions and that the questions were still difficult.

Limitations

This research is limited to the subjects of "polygons and quadrilaterals", a total of 35 students participating in the application, the "polygons achievement test" and "student opinion form".

Recommendations

In this study, in which the effect of the teaching applied using logical reasoning methods on the success of the students in the skill-based questions and the students' opinions were examined, it was concluded that the teaching using the logical reasoning methods increased the success of the students in the skill-based questions and the experimental group students generally expressed positive opinions. According to these results, some suggestions are given below.

In this study, a lesson plan based on logical reasoning methods was prepared in order to increase success in skill-based questions that require reasoning, and it has been proven to have an effect on success. In that case, it is thought that teaching by adding the skills that educators deem to be missing or need to be developed in the teaching process can be effective in helping students gain these skills.

Students are mostly afraid of skill-based questions and think that they are difficult before they have read and understood the questions. In this research, the students were given skill-based questions prepared after the activities in the lesson plan, in this way, it was aimed to increase the success of both reasoning skills and skill-based questions by constantly comparing the students with such questions in the classroom environment. Therefore, it is thought that using different activities and skill-based questions that will be prepared during the lesson for students who have prejudices against skill-based questions in mathematics and LGS exams and who are afraid of questions will help students get rid of their fears as well as an enjoyable lesson.

It is a matter that requires additional time for students to complete the reasoning process and to teach in this way. The preparation of the mathematics curriculum and textbooks by considering the logical reasoning processes of the students is considered important for the cognitive development of the 7th and 8th grade students who step into the abstract thinking period.

For researchers, it is recommended to investigate how well the lectures and questions published in the textbooks and educational information network (eba) system are suitable for the logical reasoning skills of the students.

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Conflict of Interest

The authors declared no conflict of interest.

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