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An Analysis of LGS (Transition to High School Test) Mathematics Questions in Terms of Mathematical Thinking Components

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Abstract. In this study, it is aimed to examine the high school entrance exam (LGS) questions held between 2017-2021 years in terms of mathematical thinking components. Within the scope of this research, it is aimed to examine generalization, customization, making assumptions, logical thinking and symbol usage, which are components of mathematical thinking. Qualitative research model was used in the research. With the document review form developed by the researchers, all questions were examined according to learning areas and thematic analysis was used in the analysis of the data. In the research, when the questions that appeared in LGS between the years 2017-2021 were examined, it was determined that the questions from the logical thinking component were mostly included and the questions from the generalization component were the least. Considering the learning areas, it has been determined that the logical thinking component is given weight to a large extent and the distribution of mathematical thinking components differs in each learning area. This situation is explained by the fact that the distribution of the number of questions in the learning areas is different, and it has been suggested that the distribution should be balanced according to both learning areas and mathematical thinking components in general.

Keywords. Mathematical thinking components, LGS, learning domain.

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Mathematics is considered one of the significant tools that improves thinking (Kükey, 2018). In fact Mathematics is important not because it is useful in daily life but because it teaches individuals to think accurately (Köksal, 2019). Mathematical thinking that forms in the mind of the individual is a series of processes of the individuals' interpreting the information by creating new conceptual structures with their current knowledge structure after the occurrence of preliminary knowledge regarding conceptual structures (Yakar, 2019). Mathematics education, which activates this process, assumes a function far beyond getting individuals to acquire calculating skills that are an essential part of daily life and provides individuals with important skills such as thinking, establishing connections between phenomena, reasoning, estimating, and problem solving (Umay, 2003). Thus, an array of curricula which guide individuals towards the use of metacognitive skills, which ensure meaningful and permanent learning, which are associated with previous learning, and which are integrated with other disciplines and daily life within the framework of values, skills, and competences have been created (Ministry of National Education [MoNE], 2018). Within the scope of these curricula, Transition to High School Test (Liselere Giriş Sınavı [LGS]) which 8th grade students are supposed to take at the end of the academic year was initiated as of 2017-2018 academic year. Prior to the initiation of LGS, there was High School Entrance Exam (LGS) in the early 2000s, Secondary Education Institutions Assessment and Placement test (Ortaöğretim Kurumları Seçme ve Yerleştirme Sınavı [OKS]) between 2004-2008, Placement Test (Seviye Belirleme Sınavı [SBS]) between 2008-2013, and Transition from Primary Education to Secondary Education Test (Temel Eğitimden Ortaöğretime Geçiş [TEOG]) between 2013-2017, and significant changes have been introduced to central exams in recent years (Burdur and Acar, 2019). With the start of the implementation of LGS, the questions asked in the 2017-2018 exam were examined, and it was determined that the questions that measured rational thinking competence were the highest in number, and the questions that measured operational reasoning competence were the lowest in number (Dönmez and Dede, 2020). It has been stated that mathematical thinking and reasoning skill, which individuals need to have while solving these questions, are the building blocks of mathematics education (Akdoğan, 2021).

In the field of mathematics education, in order for the students' mathematical thinking to improve, they need to have a variety of thinking skills (Bahadır, 2020). The most important one among these skills is mathematical thinking skill (Schoenfeld, 2016). In the relevant literature, studies have been encountered on many definitions of mathematical thinking and its distinctive features from other thinking skills (Liu, 2003; Mason, Burton & Stacey, 2006; Mubark, 2005; Tall,

1991). In order to concretize mathematical thinking, researchers have investigated the characteristics and components of mathematical thinking (Arslan and Yıldız, 2010). For example, while Tall (1991) determined the components of mathematical thinking as abstraction, synthesis, generalizing, modelling, problem solving, and proving, Mason, Burton, and Stacey (1982) identified the components of mathematical thinking as specializing, generalizing, conjecturing, verifying, and convincing. Liu (2003) stated that mathematical thinking consists of ability to predict, induction, deduction, description, generalizing, exemplifying, formal reasoning, informal reasoning, and verification processes. Mubark (2005), on the other hand, expressed that the components of mathematical thinking are generalizing, induction, deduction, logical thinking, using symbols, and mathematically proving. As a matter of fact, the components of mathematical thinking have been determined with different interpretations that generally have similar meanings.

In the present study, it was aimed to examine generalization, specification, conjecturing, logical thinking, and using symbols among the components of mathematical thinking. The component of "generalizing", which is defined as reaching a law based on an observation (Polya, 1990) has been expressed as a process in which general rules are discovered (Stacey, 1986). At the same time, generalizing is the process of searching for patterns and relationships based on a certain number of steps (Yıldırım and Köse, 2018). Specializing, on the other hand, is bringing together the steps that will help reach a generalization based on a few examples (Mason et al., 1985). Conjecturing is defined as the process of investigating the accuracy of a proposition by estimating that it can be accurate in a situation that seems logical but the accuracy of which has not been proven yet, and it has been stated that in this process, actions such as making a verbal or mathematical estimation, formulating mathematical claims, inferring from propositions, and building and testing hypothesis are taken (Arslan and Yıldız, 2010). While logical thinking is defined as the skill of step-by-step studying each step by justifying each step with previous steps, using symbols is expressed as the use of symbols in order to communicate mathematical ideas or verbal problems (Mubark, 2005).

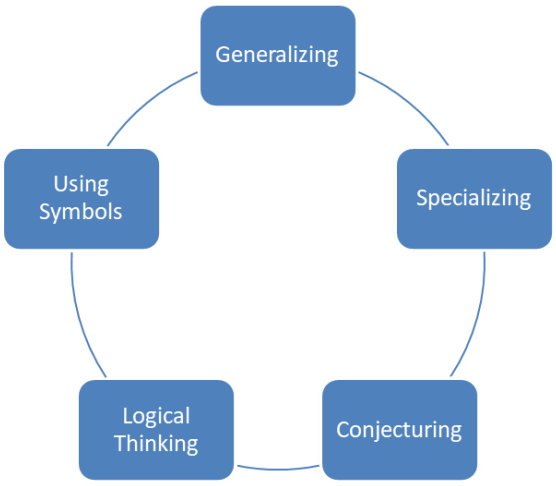

Figure 1. Components of Mathematical Thinking.

As can be seen in studies, although there is no common definition and components of mathematical thinking, it is considered a high-level thinking process that requires not only finding a solution to a problem but also managing the processes that will provide a solution to it. (Polya, 1945).

When studies conducted on mathematical thinking are examined, it is seen that there are many studies in the national literature in this regard (Akdoğan, 2021; Dalga, 2017; Aygun, 2019; Bahadır, 2020; Bas, 2019; Ersoy and Güner, 2014; Karakoca, 2011; Kılıc, Pekkan, and Toprak, 2013; Köksal, 2019; Kükey, 2018; Yıldırım and Köse, 2017; Tüzün, 2019; Yakar, 2019; Yılmaz, 2019). In the study conducted by Yılmaz (2019) in which problem establishing processes of gifted students were examined according to their mathematical thinking skills, it was found that the students had high perceptions of tendency to think at a high level. In the study conducted by Bahadır (2020), it was observed that learning environment enhanced with mathematical thinking activities increased teacher-student and student-student interaction. In their study with the participation of teachers, Ersoy and Güner (2014) determined that problem solving skills were effective on mathematical thinking. In a study conducted by Kılıc, Pekkan, and Toprak (2013) on 6th grade students, it was observed that material use improved mathematical thinking skill. In a study in which it was tried to reveal the situations of mathematical thinking related to specializing, generalizing, conjecturing, and proving experiences in 11th grade students, it was seen that the students displayed a good performance in specializing but had difficulty in proving (Arslan and Yıldız, 2010). In their study, Kükey, Aslaner, and Tutak (2019) examined the students' problem solving skills within the scope of the component of conjecturing, and they determined that the students used establishing

equations, estimating, and control strategies the most. In the study conducted by Yıldırım and Köse (2017) on secondary school students, it was found that the students who reached generalization by using a geometrical approach were able to offer explanations more easily, and that the students who used only numerical approach had difficulty in explaining the reasons for the generalization they reached. In the study conducted by Kükey (2018), the mathematical thinking processes of mathematics teachers, teacher candidates, and students were analyzed in detail in terms of conjecturing, specializing, verifying and convincing, and generalizing components. When the international literature on mathematical thinking is considered, it is seen that there have been numerous studies on mathematical thinking emergence processes and the components of mathematical thinking from past to present (Dreyfus, 1990; Mubark, 2005; Polya, 1990; Schoenfeld, 2016; Stacey, 2006; Sternberg, 2012; Tall, 1991). For instance, Cai (2003) examined the mathematical thinking processes of students in Singapore in terms of problem solving and problem establishing and determined that as the grade level increased, the students' rate of giving correct answers also increased. In a study conducted in Pakistan, a model was developed in order to measure mathematical thinking levels of secondary school students, and with this model, the students' logical thinking, generalizing, problem solving, deduction, induction, and proof processes were measured (Zaman, Ahmad, Ghaffar, and Hussain, 2021).

In addition to mathematical thinking, when studies conducted in the relevant literature on LGS are examined, it is seen that there are few studies. In the study conducted by Ekinci and Bal (2018), the 2018 LGS mathematics questions were evaluated in the context of learning domains and revised Bloom taxonomy, and it was concluded that the questions measured the cognitive processes only in the application and analysis steps. In the study they conducted, Dönmez and Dede (2020) determined that fluency competence was inquired the most and logical competence was measured the least in TEOG test, while in contrast to TEOG test, logical thinking was measured the most and operational fluency competence was measured the least in LGS mathematics questions. In the study conducted by Özturk (2020), it was concluded that questions that measure high-level skills should be included more in LGS. In the study in which the opinions of secondary school mathematics teachers on the strengths and limitations of LGS were inquired, the teachers reported that the strength of LGS was its high discrimination compared to previous exams for transition to high school, while its limitation was that it required high-level skills (Azılı and Tutkun, 2021). In another study that inquired about the opinions of secondary school mathematics teachers, difficulties experienced in the preparation process for LGS were investigated, it was determined that students

experienced problems in thinking, interpreting, understanding, and reasoning in this process, that there was no parallelism between the textbooks and the exam, which lead to various problems experienced by teachers (Obay, Demir, and Pesen, 2021). In a study in which parents' opinions on LGS were asked, while some parents expressed that the exam increased the students' anxiety and stress levels a lot, some parents reported that the exam being taken on a voluntary basis was revised with respect to previous exams (Demir and Yılmaz, 2019). In yet another study on the opinions of school administrators, school administrators stated that LGS questions were more difficult compared to the questions asked in TEOG exams (Taşkın and Aksoy, 2021).

When studies in the relevant literature were examined, no study was encountered in which mathematics questions asked in LGS for four years as of the 2017-2018 academic year were evaluated in terms of mathematical thinking components. Considering the importance of mathematical thinking that develops in students along with the development of high-level thinking skills, it was aimed in the present study to analyze LGS mathematics questions in terms of mathematical thinking skills. In line with this purpose, the answer to the question "What components of mathematical thinking among generalizing, specializing, logical thinking, using symbols, and conjecturing do the contents of mathematics questions asked in LGS cover according to learning domains?" was sought.

Method

In this part, the research model, documents analyzed, data collection tools, data collection, and data analysis have been presented.

Research Model

A basic qualitative research design was used in the study. As Yıldırım and Şimşek (1999) stated, qualitative research design enables to see the phenomenon through the perspective of the relevant individuals and to reveal the social structure and processes that constitute these perspectives. Creswell (1998) defines qualitative research design as a process of interpreting social life and human-related problems by questioning them with unique methods (p. 9). As there was no variety of data in the present study, basic qualitative research design was preferred.

Documents Analysis

In the study, a total of 80 mathematics questions that were asked in MoNE LGS test in the 2017-2018, 2018-2019, 2019-2020, and 2020-2021 academic years were categorized according to

learning domains and analyzed according to the components of mathematical thinking. In Table 1, the distribution of LGS mathematics questions asked in the relevant period according to learning domains is presented.

Table 1.

Distribution of LGS Mathematics Questions According to Learning Domains

		2017-2018		**2018-2019**		**2019-2020**		**2020-2021**		**Total**	
Learning Domain	**Learning Subdomain**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Numbers and Operations	Multiples and Factors	1	5	2	10	3	15	2	10	8	10
	Exponential Numbers	2	10	2	10	3	15	2	10	9	11.25
	Square Root Expressions	3	15	3	15	5	25	5	25	16	20
Algebra	Algebraic Expressions and Equality and Equations	2	10	1	5	3	15	2	10	8	10
	Linear Equations	3	15	3	15	0	0	2	10	8	10
	Inequations	1	5	2	10	0	0	2	10	5	6.25
Geometry and Measurement	Triangles	2	10	2	10	0	0	1	5	5	6.25
	Equality Similarity	1	5	1	5	0	0	1	5	3	3.75
	Transformation Geometry	1	5	1	5	0	0	0	0	2	2.5
	Geometric Shapes	3	15	1	5	0	0	0	0	4	5
Data Processing	Data Analysis	0	0	1	5	3	15	2	10	6	7.5
Probability	Probability of Simple Events	1	5	1	5	3	15	1	5	6	7.5
	Total	20	100	20	100	20	100	20	100	80	100

Data Collection Tools and Processes

As LGS mathematics questions were evaluated in the context of the components of mathematical thinking in the study, the questions were analyzed through document analysis. Document analysis involves the analysis of written materials that include information about the phenomenon or phenomena to be investigated (Yıldırım and Şimşek, 2021). As data collection tool, "analysis form" was prepared for the study. The indicators regarding the components of mathematical thinking were determined in line with the data obtained through literature review and a form was prepared accordingly. In the creation of the form, expert opinion was also taken (Table 2). Through this form, the mathematics questions asked in LGS were analyzed in terms of the mathematical thinking components of generalizing, specializing, logical thinking, using symbols, and conjecturing.

Table 2.

Mathematical Thinking Components and Indicators

Components	**Indicators**
Generalizing	• Thinking of similar questions • Internalizing or other practical ways • Ordering, classification and comparison of the information • Determining similarities and differences • Matching • Using the patterns • Verifying or confuting • Revising • Induction • Examining the relationships and patterns
Specializing	• Identifying the question • Narrating the question • Choosing and drawing the question • Drawing diagrams and building tables related to the question • Trying special situations and checking related examples
Logical Thinking	• Reaching information clearly through justification • Step-by-step working • Justifying each step in previous steps • Based on judgements, inferring a new judgement

Using Symbols	• Letter, relation, or abbreviation representing mathematical process • In algebra questions, using mathematical representations and symbols while solving a mathematical problem or equation
Conjecturing	• Making mathematical estimations • Formulating the claims mathematically • Deducing from propositions • Estimating the relations and results

Data Analysis

Thematic analysis was used in the study. Thematic analysis is a method used in order to identify and analyze meaning patterns in a data set (Bran and Clarke, 2006). It shows what themes are important in the definition of the phenomenon analyzed (Daly et al., 1997). Within the framework of the themes and indicators obtained as a result of the literature review, the analysis of the questions asked in LGS were performed. In order to ensure the validity of the data, the indicators that would help determine in which component of mathematical thinking the LGS questions would be included were determined by the three researchers as well as taking expert opinion. The three researchers independently coded the questions by using the mathematical thinking components tables which were created for each academic year. Miles and Huberman's (1994) formula [Agreement + (Agreement + Disagreement) x 100] was used for identifying the compliance among the researchers, and it was calculated to be 98%. In case of reliability calculations being over 70%, the coding is considered to be reliable (Miles and Huberman, 1994).

Results

In this part, the findings regarding the analysis of LGS mathematics questions asked between 2017-2021 according to learning domains in the context of the mathematical thinking components of generalizing, specializing, logical thinking, using symbols, and conjecturing are presented and discussed.

Mathematical Thinking Components by Years

Regarding the LGS mathematics questions asked between 2017-2021, what mathematical component was included to what degree is presented in the table below (Table 3).

Table 3.

Distribution of LGS Mathematics Questions According to Mathematical Thinking Components

Academic Year	Generalizing		Specializing		Logical Thinking		Using Symbols		Conjecturing	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
2017-2018	7	35	13	65	18	90	6	30	8	40
2018-2019	10	50	9	45	18	90	5	25	7	35
2019-2020	6	30	12	60	20	100	4	20	9	45
2020-2021	8	40	14	70	19	95	3	15	8	40
Total	31	38.75	48	60	75	93.75	18	22.50	32	40

It was determined that in the LGS exam held in the 2017-2018 academic year, while the questions that required logical thinking were the highest in number, the questions related with generalizing were the least in number.

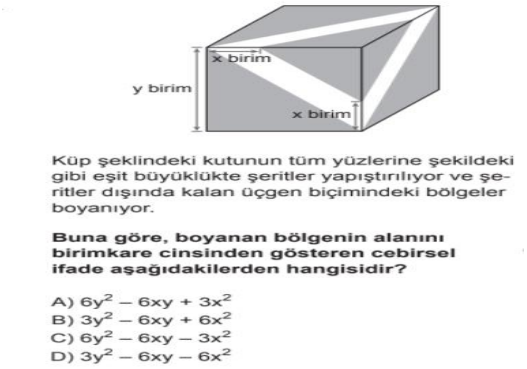

Figure 2. A sample Question Asked in the LGS Exam Held in the 2017-2018 Academic Year.

The sample question involves letters and relation that represents a mathematical process; therefore, it is seen that the component of using symbols is included (Figure 2).

It was determined that in the LGS exam held in the 2018-2019 academic year, the questions that included logical thinking were the highest in number, while the questions that comprised using symbols were the lowest in number.

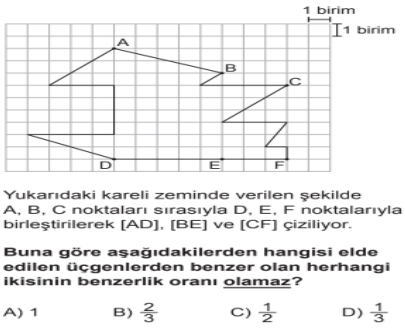

Figure 3. A Sample Question Asked in the LGS Exam Held in the 2018-2019 Academic Year.

As the sample question includes indicators such as determining similarities and differences, revising, examining the relations and patterns, verifying or refuting, it is seen that this question involves the mathematical thinking component of generalizing (Figure 3).

It was determined that in the LGS exam held in the 2019-2020 academic year, the questions that included logical thinking were the highest in number, while the questions that comprised using symbols were the lowest in number.

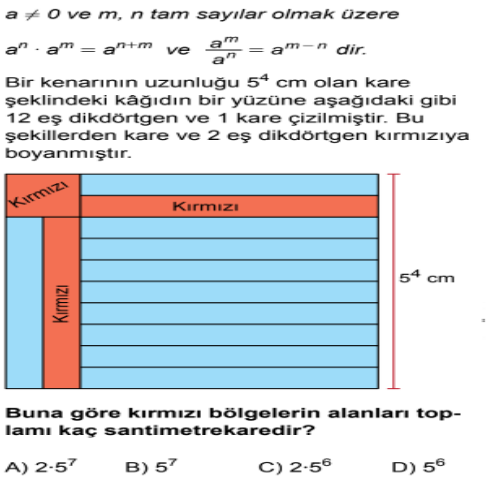

Figure 4. A Sample Question Asked in the LGS Exam Held in the 2019-2020 Academic Year.

As the sample question involves indicators such as reaching information clearly through justification, step-by-step working, inferring a new judgement based on judgements, it is seen that the logical thinking component was included in this question (Figure 4).

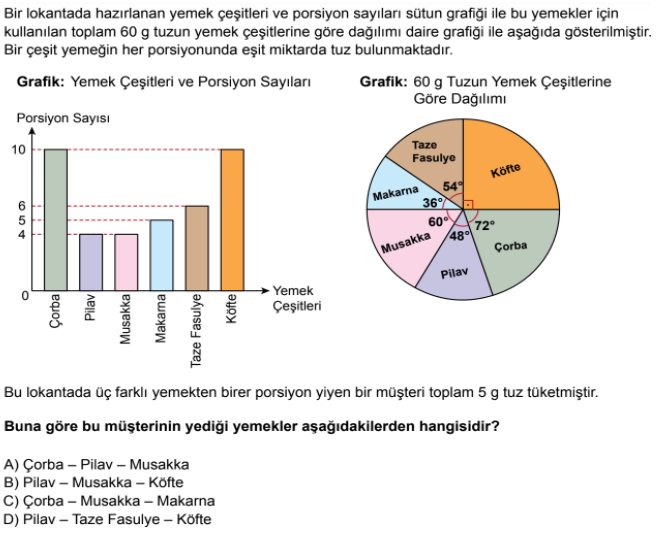

Figure 5. A Sample Question Asked in the LGS Exam Held in the 2019-2020 Academic Year.

As the sample question consists of the indicators such as making mathematical estimations, deducing from relations, and estimating relations and results, it involves the component of conjecturing (Figure 5).

It was found that in the LGS exam held in the 2020-2021 academic year, as in previous years, the questions that included logical thinking were the highest in number, while the questions that comprised using symbols were the lowest in number.

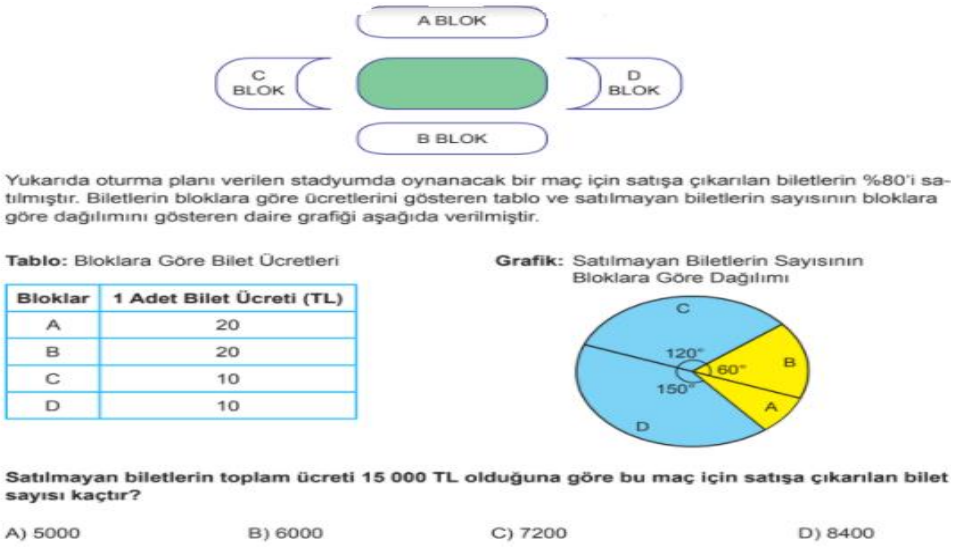

Figure 6. A Sample Question Asked in the LGS Exam Held in the 2020-2021 Academic Year.

The sample question includes the indicators of trying special situations, inductive approach, and identifying the question; therefore, the component of specializing was included in the question (Figure 6).

Evaluating the four years comparatively, it can be claimed that in all exams held in the relevant years, questions that included logical thinking were asked the most, and the questions consisting of using symbols were asked the least.

Mathematical Thinking Components According to Learning Domains

It was determined what mathematical thinking components the LGS questions covered according to each learning domain, and the findings according to the determined codes regarding mathematical thinking components are presented in the tables below.

Table 4.

Distribution of the Learning Domain of Numbers and Operations According to Mathematical Thinking Components by Years

		2017-2018	2018-2019	2019-2020	2020-2021
Numbers and Operations	**Generalizing**	1	3	4	4
	Specializing	3	2	6	6
	Logical Thinking	5	7	11	8
	Using Symbols	0	1	1	1
	Conjecturing	3	3	6	6

When the domain of numbers and operations are examined by years, an increase in questions that involve the components of generalizing, specializing, and conjecturing is observed (Table 4). In addition, it was determined that the least mathematical thinking component included in the questions was using symbols. The mathematical thinking component which was included in the exam every year was determined to be logical thinking component. It can be stated that more emphasis has been placed on questions that include mathematical thinking components in the learning domain of numbers and operations.

Table 5.

Distribution of the Learning Domain of Algebra According to Mathematical Thinking Components by Years

		2017-2018	2018-2019	2019-2020	2020-2021
Algebra	**Generalizing**	3	4	2	2
	Specializing	4	2	1	5
	Logical Thinking	5	5	3	6
	Using Symbols	4	2	3	2
	Conjecturing	4	1	0	0

It is seen that in the learning domain of algebra, the number of questions that included the mathematical thinking components of generalizing, using symbols, and conjecturing decrease towards recent years (Table 5). It was even observed that questions that included using symbols component were not asked in the last two years. On the other hand, an increase is observed in the number of questions that included the components of logical thinking and specializing. Considering

each year, it can be claimed that the questions that included logical thinking were asked the most, while the questions that included the component of conjecturing were asked the least.

Table 6.

Distribution of the Learning Domain of Geometry and Measurement According to Mathematical Thinking Components by Years

		2017-2018	2018-2019	2019-2020	2020-2021
Geometry and Measurement	**Generalizing**	3	3	0	2
	Specializing	5	3	0	0
	Logical Thinking	7	4	0	2
	Using Symbols	0	2	0	0
	Conjecturing	3	1	0	1

In the learning domain of geometry and measurement, a decrease is observed in terms of all components (Table 6). In addition, since only the subjects covered in the first semester of the 2019-2020 academic year were included in the exam due to the pandemic, there were no questions on geometry and measurement domain. It was also determined that in the LGS exam held in the 2020-2021 academic year, questions related to the components of specializing and using symbols were not included.

Table 7.

Distribution of the Learning Domain of Data Processing According to Mathematical Thinking Components by Years

		2017-2018	2018-2019	2019-2020	2020-2021
Data Processing	**Generalizing**	0	0	0	0
	Specializing	0	1	3	2
	Logical Thinking	0	1	3	2
	Using Symbols	0	0	0	0
	Conjecturing	0	0	1	0

It was determined that in the learning domain of data processing, questions that included the components of specializing and logical thinking were asked (Table 7). In the LGS exam held in the 2017-2018 academic year, there were no questions on the learning domain of data processing.

Considering the questions asked in the four years, questions that included the components of using symbols and generalizing were not asked at all.

Table 8.

Distribution of the Learning Domain of Probability According to Mathematical Thinking Components by Years

		2017-2018	2018-2019	2019-2020	2020-2021
Probability	**Generalizing**	0	0	0	0
	Specializing	1	1	2	1
	Logical Thinking	1	1	3	1
	Using Symbols	0	0	0	0
	Conjecturing	0	1	2	0

When the questions asked in the four years on the learning domain of probability were examined, it was found that questions on generalizing and symbol using were not included (Table 8). In general, questions consisting of the components of specializing, logical thinking, and using symbols were more prominent. In the last year, only questions consisting of specializing and logical thinking were included. It can be stated that the reason for including fewer questions consisting of mathematical thinking components in the learning domain of probability may be the few number of questions asked on this domain.

Discussion, Conclusion, and Recommendations

In the present study, mathematics question asked in LGS exams held between 2017-2021 years were analyzed according to learning subdomains in terms of the mathematical thinking components of generalizing, specializing, logical thinking, using symbols, and conjecturing. The analysis of the questions asked in LGS exams between 2017-2021 years demonstrated that the highest number of questions included the component of logical thinking, while the lowest number of questions consisted of the component of generalizing. This finding is in parallel with the finding obtained in the study conducted by Do.

Dönmez and Dede (2020), which showed that questions including the component of logical thinking in LGS exams were the highest in number. It can be stated that the increase in the number of questions that included the component of logical thinking in recent years may be associated with the high-level thinking skills expected from students. This finding is similar to the judgement made

by Öztürk (2020) stating that more questions that require high-level thinking skills should be included in LGS exams. Moreover, the superior aspect of LGS compared to previous exams for transition to high school being its high discriminating feature, and its limitation being its requirement of high level-thinking skills (Azılı and Tutkun, 2021) explain this situation.

Regarding the analysis according to learning domains, it was determined that there was an increase in the number of questions in the numbers and operations learning domain that included generalizing, specializing, and conjecturing components by years, and that logical thinking component was included the most. It was found that there was a decrease in the number of questions in the learning domain of algebra that included generalizing, using symbols, and conjecturing components in recent years. On the other hand, an increase was observed in the number of questions that included the components of logical thinking and specializing. Considering each year, it can be stated that in the learning domain of algebra, questions that included logical thinking were the highest in number, while questions including the component of conjecturing were the lowest in number. Decreases and increases in mathematical thinking components in the learning areas of numbers and operations and algebra show that there is no certain stability. What is common in both learning areas is that more emphasis has been placed on the logical thinking component in recent years. The increase in the logical thinking component in recent years can be explained by the application of the questions that measure high-level skills such as analysing, interpretation, problem solving, etc. in LGS (Tüzün & Cihangir, 2020).

It is seen that there was a decrease in the geometry and measurement learning domain in the last two years in terms of all components. It was also determined that questions that involved the components of specializing and using symbols were not included at all in the LGS exam held in the 2020-2021 academic year. This finding shows that the distribution according to the components was not considered in the questions related with the learning domain of geometry and measurement. It was found that questions consisting of specializing and logical thinking components were not included in the learning domain of data processing. It was also determined that questions that involved using symbols and generalizing components were not included at all in the questions asked in the four years. This situation can be explained by the thought that the learning domain of data processing is not suitable for the indicators of the component of using symbols.

Regarding the questions on the learning domain of probability in the four years, it was seen that questions consisting of generalizing and using symbols components were not included at all. In

general, questions that included specializing, logical thinking and using symbols were more emphasized. In the last year, only one question consisting of specializing and logical thinking was included. It can be stated that the fact that mathematical thinking components were included less in the learning domain of probability may have stemmed from the few number of questions asked in this domain.

A general overview of learning domains showed that the component of logical thinking was emphasized at a great rate, and that the distribution of mathematical thinking components in each learning domain varied. This situation can be accounted for by the different distributions of question numbers in the learning domains. As a matter of fact, this finding overlaps with the result that there are learning outcomes in the 8th grade mathematics curriculum related with all learning domains, but that a complete agreement between the exam questions and learning outcomes does not exist (Ekinci and Bal, 2019). It is recommended that the distribution of the LGS questions should be balanced according to both learning domains and mathematical thinking components.

About Authors

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