

Determining The Statistical Reasoning Levels Of Gifted Students ¹

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Abstract

The purpose of this study is to determine the statistical reasoning levels of gifted middle school students, and to examine these levels in terms of variables such as grade level and parental education status. The research was conducted with 150 students attending Science and Art Centres (BİLSEM) in İzmir, and the students' statistical reasoning skills were measured using LOCUS Assessment Questions. A correlational survey model was used in the study. The data were analysed using quantitative methods. The study found that gifted students had low levels of statistical reasoning skills. Furthermore, analysis of grade levels revealed that 7th and 8th grade students performed better than 6th grade students, but there was no significant difference between 7th and 8th grades. No significant difference was observed between parents' educational status and students' reasoning levels. The results reveal that, despite gifted students' high analytical thinking abilities, they struggle to understand complex statistical concepts, and that their education in this area needs to be strengthened in greater depth.

Keywords: *gifted students, statistical reasoning levels, grade level, parents' educational status*

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Introduction

With the changing world order, the importance of statistical reasoning skills has increased in recent years. The GAISE II report emphasizes the importance of using statistical reasoning skills to understand the changing world order (Bargagliotti et al., 2020). According to this report, statistical reasoning skills enable individuals to analyze the data they encounter in their lives and make evidence-based decisions. These skills allow individuals to evaluate the accuracy of statistical information and understand the variability they encounter in their daily lives. Furthermore, statistical reasoning skills are essential for questioning data, collecting and analyzing data from various sources, and drawing conclusions. The use of statistical reasoning skills by individuals is crucial not only for their own lives but also for fulfilling their responsibilities as members of society (Bargagliotti et al., 2020). Statistical reasoning enables individuals to respond intelligently to numerical information in their environment (Ben-Zvi & Garfield, 2004). For statistical reasoning to be incorporated as a concept in education and teaching, it is first necessary to understand this concept. In the literature, statistical reasoning is defined as individuals' use of statistical ideas to reason and interpret statistical information (Garfield et al., 2003). The foundation of statistical reasoning and data interpretation is the statistical research process (Bargagliotti et al., 2020). The GAISE II report states that the statistical research process consists of four steps: formulating a statistical research question, collecting and organizing data, analyzing data, and interpreting results. Understanding, explaining, and measuring variability in data within a given context is fundamental to the statistical research process (Bargagliotti et al., 2020).

Within the education system, not every individual possesses the same level of ability, and there are children who exhibit individual differences within basic education. One group of students who exhibit individual differences is gifted students. Although no single criterion is used in studies conducted to identify gifted individuals, they consistently perform well in three related clusters. These clusters are above-average ability, task commitment, and creativity (Renzulli, 2003). A single cluster does not indicate giftedness on its own; rather, all clusters interact with one another. This interaction is represented in the shaded (middle intersection) section of the model. Renzulli (2003) points out that each cluster plays an important role in an individual's giftedness. In the above-average ability cluster, high performance in general and specific ability areas is essential. Task commitment is defined as perseverance, resilience, hard work, self-confidence, and the ability to carry out important work. The creativity cluster is based on fluency, flexibility, and originality of thought; openness to different ideas and experiences; curiosity; adventurousness; risk-taking; and attention to detail (Renzulli, 2003).

Sternberg and Grigorenko (2002) developed a model for identifying and evaluating gifted students in the Theory of Successful Intelligence. This model states that gifted individuals demonstrate strengths in practical, analytical, and creative abilities and achieve success by combining these abilities (Sternberg & Grigorenko, 2002). In Turkey, gifted individuals are defined as "individuals who learn faster than their peers; who are advanced in creativity, art, and leadership capacity; who have special academic abilities; who can understand abstract ideas; who prefer to act independently in their areas of interest; and who perform at a high level" (Ministry of National Education [MEB], 2019, p. 393). Due to the distinct cognitive, personal, and emotional characteristics of gifted students, determining their level of statistical reasoning is an important research topic. Because gifted students possess strong problem-solving skills, high-level cognitive and abstract thinking abilities, associative thinking skills, and a tendency toward debate (Clark, 2015; Levent, 2011), examining their statistical reasoning skills is particularly important for developing educational content appropriate to their abilities and for organizing educational activities tailored to their needs.

Most studies in the literature examining students' statistical reasoning skills have been conducted with middle and high school students with typical development (Aoyama & Stephens, 2003; Batur & Baki, 2022; Bayrak, 2024; Ben-Zvi, 2004; Gil & Ben-Zvi, 2010; Güray et al., 2019; Güven et al., 2015; Karaca & Ay, 2025; Koparan & Güven, 2013, 2014; Koparan et al., 2014; McClain et al., 2000; Mooney, 2002; Öz, 2019; Öztürk Zora & Anapa Saban, 2023; Pfannkuch, 2006; Watson et al., 2014; Watson & English, 2017; Yolcu, 2012, 2014). Watson and Kelly (2008) examined the statistical reasoning skills of students at the elementary, middle school, and high school levels. These studies reported that high school students' statistical reasoning levels were generally low (Batur & Baki, 2022; Koparan & Güven, 2013).

In their study, Batur and Baki (2022) observed that some high school students answered LOCUS questions at an inadequate level, some at an intermediate level, and others at an advanced level. Yolcu (2012) reported similar results for eighth-grade middle school students, finding that their statistical reasoning levels were low. Koparan and Güven (2013) found that although sixth-, seventh-, and eighth-grade students demonstrated high levels of statistical reasoning in defining data, they exhibited low levels in organizing and reducing data, data representation, and data analysis and interpretation.

In the study conducted by Bayrak (2024), the statistical reasoning skills of eighth-grade students were examined within the framework of the M3ST statistical thinking model. The results were similar to those of Koparan and Güven (2013) in terms of defining data and data presentation processes. However, students were found to be at Level 3 in organizing and reducing data and at Level 2 in analyzing and interpreting data, yielding different results from Koparan and Güven (2013). Furthermore, studies indicate that students experience difficulties in understanding statistical concepts (Aydın, 2020; Batur & Baki, 2022; Gil & Ben-Zvi, 2010; Mooney, 2002; Öz, 2019; Özdemir, 2014; Watson et al., 2014). These difficulties are particularly evident in graph interpretation and measures of central tendency (Batur & Baki, 2022), data collection (Öz, 2019), and data analysis and interpretation (Aydın, 2020). Koparan et al. (2014) found that high school students struggled to use contextual and statistical information together. Some studies also indicate that statistical reasoning levels vary according to grade level (Kale, 2024; Watson & Kelly, 2008).

In addition to studies examining the statistical reasoning skills of typically developing students, there are studies in the literature that investigate the statistical reasoning skills of gifted students; however, these studies are limited in number (Durak & Tutak, 2019; Ko, 2012, 2013). Durak and Tutak (2019) compared the statistical reasoning skills of ninth-grade gifted students and students with typical development. Their findings revealed that gifted students were more successful than their typically developing peers in four categories of statistical reasoning, while demonstrating similar reasoning skills in the remaining four categories. Ko (2012) conducted a similar study comparing the statistical reasoning skills of gifted and typically developing students at both the elementary and middle school levels, with a focus on variability modeling and understanding sampling distributions. The results showed that gifted students performed better in variability modeling, while demonstrating similar reasoning skills in understanding sampling distributions. Overall, gifted students were found to experience difficulties in both variability modeling and sampling distributions. Ko (2013) conducted a related study on defining variability, comparing gifted and typically developing elementary and middle school students. The results revealed a significant difference in statistical reasoning skills between the two groups; however, the analyses indicated that gifted students' statistical reasoning levels were not consistently high and that there were overlapping characteristics with typically developing students.

A review of the literature indicates that students' statistical reasoning levels have been examined in relation to a limited number of variables. Studies that comprehensively examine the statistical reasoning levels of gifted students in terms of multiple variables (e.g., parental education status, grade level) are quite limited. This study aims to contribute to the field by comprehensively examining the statistical reasoning levels of gifted students in relation to various variables, including parental education status and grade level. Examining gifted students' statistical reasoning skills across different variables will provide guidance for educators and policymakers and inform program development and the improvement of teaching methods. Accordingly, this study aims to determine the statistical reasoning levels of gifted middle school students (sixth, seventh, and eighth grades) and to examine these levels in terms of grade level and parental education status.

In this context, the sub-problems of the study are as follows:

1. How are the statistical reasoning levels of gifted students (sixth, seventh, and eighth grades) distributed?
2. Are there statistically significant differences in the statistical reasoning levels of gifted students according to grade level (sixth, seventh, and eighth grades)?

3. Do the statistical reasoning levels of gifted students (sixth, seventh, and eighth grades) differ significantly according to their parents' educational status?

Method

Research Model

This research was conducted to determine the statistical reasoning levels of gifted middle school students and to examine these levels in terms of various variables. The correlational survey model, one of the quantitative research designs, was used in the study. The correlational survey model is defined as a research design aimed at determining the relationships between two or more variables (Karasar, 2020). Within the scope of the research, the statistical reasoning levels of gifted students were examined by making comparisons in terms of the variables of students' grade levels and parents' education status. For these purposes, the correlational survey model (comparative) was selected as an appropriate approach.

Study Group

The study group for the research consists of gifted 6th, 7th, and 8th grade students enrolled at the Science and Art Center (BİLSEM) in Bornova and Çiğli, İzmir, during the 2024-2025 academic year. Seventy-five participants were selected from a BİLSEM in Çiğli, and 75 were selected from a BİLSEM in Bornova. A total of 150 students participated in the study. The Science and Art Centers in Bornova and Çiğli were selected because they have a large number of students and students from different socio-economic levels in Izmir attend them. The study group was selected using a convenience sampling method from among students in grades 6, 7, and 8. Table 1 presents the demographic characteristics of the sample.

Table 1

Descriptive Statistics of Demographic Variables in the Sample

| Variable | | f | % |
|---------------------------|-----------------------------|-----|------|
| Gender | Female | 63 | 42 |
| | Male | 87 | 58 |
| Grade Level | 6 | 52 | 34.7 |
| | 7 | 52 | 34.7 |
| | 8 | 46 | 30.7 |
| Mother's Education Status | Primary School Graduate | 12 | 8 |
| | High School Graduate | 21 | 14 |
| | University Graduate | 84 | 56 |
| | Master's/Doctorate Graduate | 33 | 22 |
| Father's Education Status | Primary School Graduate | 8 | 5.3 |
| | High School Graduate | 22 | 14.7 |
| | University Graduate | 88 | 58.7 |
| | Master's/Doctorate Graduate | 32 | 21.3 |
| | Toplam | 150 | 100 |

Data Collection Tools

As data collection tools, "LOCUS Assessment" questions were used to determine students' statistical reasoning, and a "Demographic Information Form" was used to collect data on students' demographic information (age, gender, grade level, school type, parents' educational status).

LOCUS Assessment Questions

Levels of Conceptual Understanding in Statistics (LOCUS) is a DRK12 project funded by the NSF that focuses on assessing individuals' conceptual understanding of statistics (Jacobbe et al., 2014). The goal of this project is to provide a valid and reliable assessment tool that measures broad statistical thinking skills for use by teachers, educational leaders, assessment specialists, and researchers, consistent with the Common Core State Standards (CCSS) (Jacobbe et al., 2014). The assessment tools developed are intended for grades 6-12 (ages 11-18). The LOCUS project differs from traditional large-scale assessments in several ways. The first difference is that this project aims to measure conceptual understanding at all stages of the statistical problem-solving process (Franklin et al., 2007), thereby eliminating the importance of rote and procedural measurement. Second, it takes into account the distinction between mathematical and statistical reasoning by stating that statistical reasoning is inextricably linked to context and must account for variability at every stage (DelMas, 2005). Questions at each grade level are structured for all stages of the three-level (beginner, intermediate, advanced) statistical problem-solving process described in the GAISE (Franklin et al., 2007) report (see <https://locus.statisticseducation.org/>). The developers of the LOCUS assessment were selected from experts in the field. LOCUS assessment questions are considered a valid and reliable tool for measuring students' current statistical understanding and evaluating their development (Jacobbe et al., 2014).

In this study, questions from the LOCUS project (Jacobbe et al., 2014) were used to examine the statistical reasoning levels of gifted students. To this end, the necessary permissions were obtained for the questions selected from the website where LOCUS sample questions are shared (see <https://locus.statisticseducation.org/>) and adapted into Turkish (Batur & Baki, 2022). Then, expert opinion was sought to assess whether the LOCUS assessment questions were sufficient to measure the statistical reasoning levels of gifted students. For content validity of the questions, the opinions of 2 program development specialists, 2 faculty members working in gifted education and mathematics, 1 mathematics teacher with a doctorate in statistical reasoning, and 1 assessment specialist were sought. As a result of the evaluations, it was unanimously agreed that the LOCUS questions were suitable for use in examining the statistical reasoning levels of gifted middle school students. A pilot study was conducted with 20 students to check the comprehensibility of the questions. The questions were found to be understandable and clear to the students. The LOCUS questions are based on open-ended qualitative data analysis, and a second expert opinion was required for the evaluation of some student responses. The rubric for scoring the answers to the LOCUS questions was provided in a very clear manner. This allowed for a clear scoring process of the students' responses. However, to increase the reliability of the study, it was requested that someone other than the researchers also perform the evaluation.

To assess the reliability of the LOCUS questions, the data was reviewed by a high school mathematics teacher working at the Science and Art Center, who specializes in mathematics education, in addition to the researchers. The inter-rater reliability, calculated according to the reliability formula (Reliability = $\frac{\text{Agreement}}{\text{Agreement} + \text{Disagreement}} \times 100$) proposed by Miles and Huberman (1994), was calculated as 99.636% based on the view coding performed by three researchers and one expert. In this sense, the findings were obtained based on the assumption that the analysis performed by the researchers was reliable.

In the study, a total of 11 LOCUS assessment questions covering the steps of the statistical research process (identifying the problem situation, collecting and organizing data, analyzing data, interpreting results) were used to determine the statistical reasoning levels of gifted students.

Demographic Information Form

The demographic information form is a data collection tool used to gather the basic characteristics of the participants in the study. This form includes information such as the participants' age, gender, grade level, and parents' educational status. These demographic data were used to examine variables that could be related to the participants' levels of statistical reasoning. Participants' personal information was collected anonymously and analyzed solely for the purpose of the research. The demographic form enabled a more in-depth analysis of the research findings and comparisons between different groups.

Data Analysis

In the study examining the statistical reasoning levels of gifted students in terms of various variables, the data were evaluated quantitatively. The IBM SPSS Statistics 24 program was used to analyze the quantitative data. The statistical reasoning levels of gifted students were determined by analyzing their responses to the LOCUS assessment questions. The students' responses were analyzed based on the categorical scoring scale revised during its adaptation into Turkish as part of the research conducted by Batur and Baki (2022). In the categorical scoring scale revised by Batur and Baki (2022), each question was scored at three levels: "Insufficient (0 points)", "Moderate (1 point)", and "Advanced (2 points)". "Responses with weak statistical content, where personal opinions are more prominent, and cannot be directly related to the context, were scored in the Insufficient (0 point) category. Responses showing students' awareness of statistical concepts were scored in the Moderate (1 point) category. Responses where students supported their explanations with statistical evidence were scored in the Advanced (2 points) category." (Batur and Baki, 2022). Table 2 shows an example of how a gifted student's response to one of the LOCUS questions was analyzed according to the categorical scoring scale.

Table 2

Example Question Analysis Using the Categorical Scoring Scale

| | |
|---|--|
| Student Response | <p>1.b. 100 öğrenciden oluşan örnekleme nasıl seçersiniz? Açıklayınız.</p> <p>Tecrübeli, insanlar mesela o ^{seor} işte ilgili birilerine sormak daha mantıklı olabilir.</p> |
| Analysis According to the Categorical Scoring Scale | The student was rated as inadequate (Inadequate/0) because they provided answers that leaned toward biased sample selection, such as experienced people or those interested in sports. |

The students' answers to the LOCUS assessment questions were analyzed according to the categorical scoring scale to obtain their total scores. These scores were analyzed using descriptive statistics (frequency, percentage, mean, and standard deviation). The results obtained were evaluated according to the cut-off score ranges created. The cut-off score ranges used in the research by Batur and Baki (2022) were determined based on the formula $\text{width} = \text{range width} / \text{desired number of groups}$. The scores for the answers to the questions ranged from 0 to 2, and the statistical reasoning

levels were established as Low (.00-.66), Medium (.67 - 1.33), and Good (1.34 - 2.00) (Batur & Baki, 2022).

The results of the normality test conducted to determine whether the answers given by the students participating in the study to the LOCUS Assessment questions and the demographic form were normally distributed are presented in Table 3.

Table 3

Normality Test Results

| Variables | | Skewness and Kurtosis Values | | | Kolmogorov-Smirnov Test | | | |
|----------------------------------|-------------------------|------------------------------|------------|----------|-------------------------|------------|----------------|------|
| | | Skewness | Std. Error | Kurtosis | Std. Error | Statistics | Standard Error | p |
| Grade Level | 6th Grade | .58 | .330 | .047 | .650 | .108 | 52 | .189 |
| | 7th Grade | .175 | .333 | -.323 | .656 | .145 | 51 | .009 |
| | 8th Grade | .809 | .354 | .793 | .695 | .174 | 45 | .002 |
| Mother's Education Status | Primary School Graduate | 1.560 | 0.637 | 3.801 | 1.232 | 0.214 | 12 | .134 |
| | High School Graduate | .825 | .501 | 1.330 | .972 | .163 | 21 | .151 |
| | University Graduate | -.033 | .263 | .165 | .520 | .136 | 84 | .001 |
| | Master's/ | .438 | .409 | -.755 | .798 | .159 | 33 | .033 |
| | Doctorate Degree Holder | | | | | | | |
| Father's Educational Status | Primary School Graduate | 2.128 | .752 | 5.078 | 1.481 | .314 | 8 | .020 |
| | High School Graduate | .171 | .491 | 2.611 | .953 | .232 | 22 | .003 |
| | University Graduate | -.038 | .257 | -.174 | .508 | .137 | 88 | .000 |
| | Master's/ | .574 | .414 | -.552 | .809 | .230 | 32 | .017 |
| | Doctorate Degree Holder | | | | | | | |
| LOCUS Assessment Question Scores | | .342 | .198 | .407 | .394 | .136 | 150 | .000 |

* $p < 0.05$

To test whether the data obtained from the study showed a normal distribution across groups, skewness and kurtosis values were used. Histograms and Q-Q plots were also examined. Tabachnick and Fidell (2013) accept that the distribution is normal when skewness and kurtosis values are between +1.5 and -1.5. When these values were examined according to grade level, the kurtosis and skewness values were found to be between +1.5 and -1.5. Therefore, for the comparison of values belonging to three or more groups (grade level), descriptive statistics, one-way ANOVA, and LSD test analysis were performed for groups showing a normal distribution. To test the significance of the findings obtained between these groups, Tukey HSD tests were used from the Post Hoc test methods. When the values were examined according to the educational status of the parents, it was seen that some kurtosis and skewness values were not between +1.5 and -1.5 (e.g., the group of parents with primary education). For this reason, the Kruskal Wallis test was performed for groups that did not show a normal distribution (parental educational status) when comparing values belonging to three or more groups. Within this scope, parametric tests were used in the analyses of students' statistical reasoning levels according to their grade levels, while non-parametric tests were used in the analyses related to the educational status of parents. The eta-square (η^2) value was calculated to determine the effect size in parametric and non-parametric tests. The eta-squared value provides information about how much of the total variance in the dependent variable is explained by the independent variable (Cohen, 1992). Eta-squared is considered to be a small effect size at .01, a medium effect size at .06, and a large effect size at .14 (Cohen, 1992).

Findings

Findings Regarding the Determination of Statistical Reasoning Levels of Gifted Students

The distribution of the mean scores obtained by gifted students on the LOCUS questions in terms of their statistical reasoning levels, along with the standard deviation values for each mean score, is presented in Figure 1.

Figure 1

Distribution of Scores Obtained by Gifted Students on LOCUS Questions in Terms of Statistical Reasoning Levels

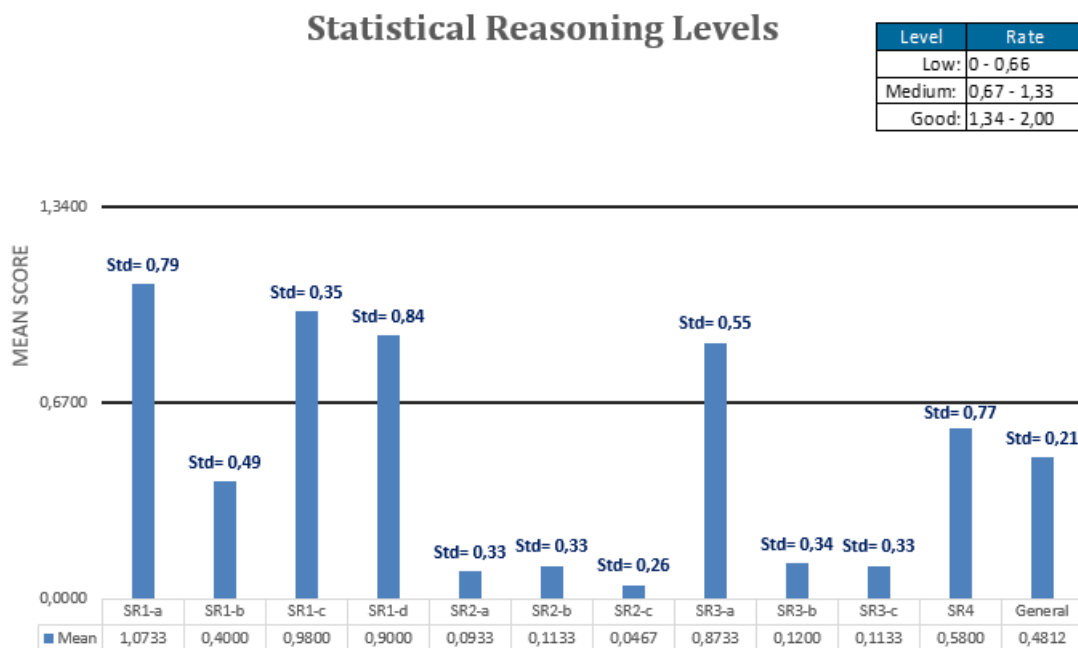


Figure 1 shows that the average scores of gifted students on the LOCUS questions range from .04 to 1.07. It was observed that gifted students scored at a "Low" level on 7 of the 11 questions (SR1-b, SR1-a, SR2-b, SR2-c, SR3-b, SR3-c, SR4). When examining the questions on which students scored low, it was observed that they scored particularly low on questions related to graph interpretation and inference, namely SR2-a (\bar{x} = .0933), SR2-b (\bar{x} = .1133), SR2-c (\bar{x} = .0467), SR3-b (\bar{x} = .1200), SR3-c (\bar{x} = .1133) questions. In addition, gifted students were found to be at an "intermediate" level in questions coded SR1-a (Identifying the problem situation), SR1-c (Selecting appropriate tables and graphs), SR1-d (Reading tables and graphs), and SR3-a (Creating graphs). Students achieved the highest average score (\bar{x} = 1.0733) on the question coded as SR1-a (Identifying the problem situation). Examination of Figure 1 reveals that gifted students could only reach the "Intermediate" level at most on the LOCUS questions. When examining the standard deviations of the LOCUS questions, it was found that the lowest standard deviation belonged to the SR2-c (graph interpretation and inference) coded question, while the highest standard deviation belonged to the SR1-a (problem situation identification) coded question. This situation shows that gifted students are most in agreement on the question coded SR2-c in the LOCUS questions, while they are least in agreement on the question coded SR1-a. Furthermore, it was determined that the overall average score calculated to determine the statistical reasoning levels of gifted students (\bar{x} = .4812) was low. Based on this calculated average score, it was observed that the statistical reasoning of gifted students was at a "Low" level. The overall standard deviation of the students' answers to the LOCUS questions was calculated as .21599. This value shows us that, in general, gifted students were in agreement in their answers to the LOCUS questions, meaning that there was consistency among the students' answers.

The results showing the distribution of the scores gifted students received on the LOCUS questions according to the relevant categories are presented in Table 4.

Table 4

Distribution of Points Obtained from LOCUS Questions According to Relevant Categories

| Question Code | Insufficient | | Average | | Advanced | |
|---------------|--------------|--------------|------------|--------------|------------|-------------|
| | f | % | f | % | f | % |
| SR1-a | 42 | 28 | 55 | 36.7 | 53 | 35.3 |
| SR1-b | 90 | 60 | 60 | 40 | 0 | 0 |
| SR1-c | 11 | 7.3 | 131 | 87.3 | 8 | 5.3 |
| SR1-d | 62 | 41.3 | 41 | 27.3 | 47 | 31.3 |
| SR2-a | 138 | 92 | 10 | 6.7 | 2 | 1.3 |
| SR2-b | 134 | 89.3 | 15 | 10.0 | 1 | .7 |
| SR2-c | 145 | 96.7 | 3 | 2 | 2 | 1.3 |
| SR3-a | 34 | 22.7 | 101 | 67.3 | 15 | 10 |
| SR3-b | 133 | 88.7 | 16 | 10.7 | 1 | .7 |
| SR3-c | 134 | 89.3 | 15 | 10 | 1 | .7 |
| SR4 | 89 | 59.3 | 35 | 23.3 | 26 | 17.3 |
| TOTAL | 1012 | 61.33 | 482 | 29.21 | 156 | 9.45 |

Maximum per question: 2, minimum: 0

Table 4 shows that 61.33% of gifted students answered LOCUS questions in the inadequate category. It was determined that 29.21% of students answered in the intermediate category, while 9.45% answered in the advanced category. The overall picture shows that more than half of gifted students were unable to answer the LOCUS questions at a statistically sufficient level.

Highly gifted students appear to struggle most with questions involving graphic interpretation and inference (SR2-a, SR2-b, SR2-c, SR3-b, SR3-c). Among these questions, the one with the lowest average score is SR2-c ($\bar{x} = .0467$). 96.7% of students answered this question in the inadequate category. Most students left the question blank and were unable to answer it. The majority of students who answered the question gave personal responses that did not support the question. Two percent of the students gave answers in the intermediate and advanced categories. Table 5 shows a sample of the students' answers according to different categories.

Table 5

Examples of Student Responses Related to Graph Interpretation and Drawing Conclusions

| CODE | Student Responses | Category |
|------|--|--------------|
| Ö84 | <p>2.c. Atletlerin uzun mesafe ve yarı maraton yarışlarından birini seçtiği bilgisine göre, grafiklerdeki verilere dayalı olarak bir atletin yarı maratondaki tur zamanının uzun mesafedeki tur zamanından daha az olacağını söyleyebilir misiniz? Cevabınızı gerekçelendirerek açıklayınız.</p> <p>Evet çünkü yarı mesafe koşucuları 15. dakikada turlarını bitirirken uzun mesafe koşucuları daha 22. dakika bitirmiş olur.</p> | Insufficient |
| Ö81 | <p>2.c. Atletlerin uzun mesafe ve yarı maraton yarışlarından birini seçtiği bilgisine göre, grafiklerdeki verilere dayalı olarak bir atletin yarı maratondaki tur zamanının uzun mesafedeki tur zamanından daha az olacağını söyleyebilir misiniz? Cevabınızı gerekçelendirerek açıklayınız.</p> <p>Söyleyemezsiniz çünkü grafikte yok?</p> | Average |
| Ö57 | <p>2.c. Atletlerin uzun mesafe ve yarı maraton yarışlarından birini seçtiği bilgisine göre, grafiklerdeki verilere dayalı olarak bir atletin yarı maratondaki tur zamanının uzun mesafedeki tur zamanından daha az olacağını söyleyebilir misiniz? Cevabınızı gerekçelendirerek açıklayınız.</p> <p>Değişkenlik gösterebilir, mesela en hızlı uzun mesafe koşucusu, daha kısa sürede yapar!</p> <p>Ortalama (12-18 arası) bir uzun mesafe koşucusu ortalama yapardı</p> <p>Ortalama</p> <p>Kötü (18-22 arası) bir uzun mesafe koşucusu ortalamanın altında yapardı</p> <p>Ortalamanın altında</p> <p>Ortalamanın üstünde</p> | Advanced |

When examining the student response coded as Ö84 in Table 5, it is seen that they completely misinterpreted the histogram graph. When interpreting the graph, the student failed to use the concept of distribution, assuming that half marathon runners would complete the lap in 15 minutes and long-distance runners in 22 minutes. Furthermore, the student's answer was categorized as inadequate because they interpreted the data based on groups rather than individual athletes, and could not establish a relationship between the average lap time and each data point. Student Ö81 stated that they could not answer, but was evaluated as average because they could not provide a statistically complete explanation. Student Ö57, however, recognized that the group's lap completion time could not be reduced to an individual and provided an explanation establishing a relationship between the average lap time and each data point, and was evaluated as advanced.

There are also questions where gifted students scored at an intermediate level (SR1-a (Identifying the problem situation), SR1-c (Selecting appropriate tables and graphs), SR1-d (Reading tables and graphs), and SR3-a (Creating graphs)). The question with the highest average score among these is SR1-a ($\bar{x} = 1.0733$). Twenty-eight percent (28%) of the students gave answers in the insufficient category. The majority of students who answered in the insufficient category either left the question blank or gave answers that included instructions. Thirty-six point seven percent (36.7%) of the students responded in the intermediate category, and 35.3% in the advanced category. It was observed that the majority of students who responded in the intermediate category created incomplete or ambiguous research questions. Table 6 shows a sample of students' responses according to different categories.

Table 6

Sample Student Responses Related to Problem Identification

| CODE | Student Responses | Category |
|------|--|--------------|
| Ö101 | <p>1.a. Sizce ankette sorulabilecek araştırma sorusu nasıl olmalıdır? Ankette olması gerektiği gibi yazınız.</p> <p>nek: → En sevdiğiniz spor branşını seçiniz, en sevdiğiniz bu branş eğer en fazla oy alan branş ise gelecek yıl o spor branşını dersinize eklenicaktır.</p> | Insufficient |
| Ö99 | <p>1.a. Sizce ankette sorulabilecek araştırma sorusu nasıl olmalıdır? Ankette olması gerektiği gibi yazınız.</p> <p>Açıklayıcı, okunu hakkında bilgi verici olmalıdır.</p> <p>ör: Tevsiye ettiğiniz spor dalı nedir?</p> | Average |

SORU 1: Kalabalık bir lisenin öğrenci kulübünden, bir sonraki yıl beden eğitimi dersi programına eklenmek üzere çeşitli spor branşlarından birini tavsiye etmesi istenmiştir. Kulüp öğrencileri bunun için 100 öğrenciye futbol, tenis, basketbol ve yüzme branşları arasında en sevdikleri etkinliği seçebilecekleri bir anket uygulamaya karar vermiştir.

1.a. Sizce ankette sorulabilecek araştırma sorusu nasıl olmalıdır? Ankette olması gerektiği gibi yazınız.

Advanced

Ö119

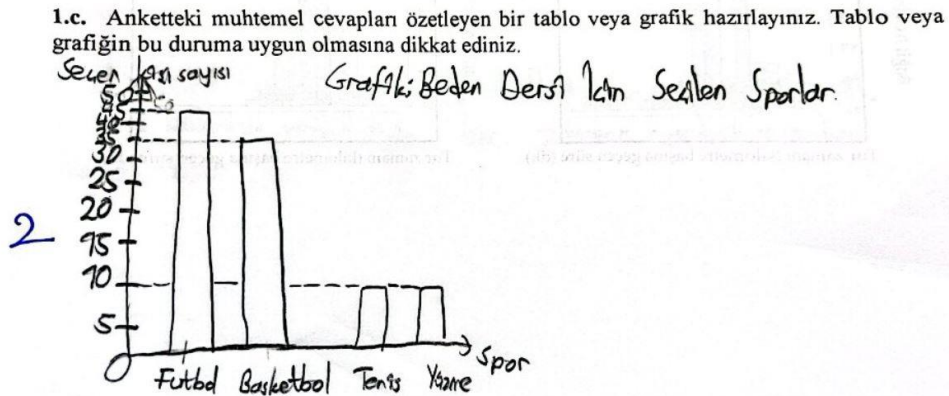
Beden eğitime futbol, tenis, basketbol ve yüzme branşlarına eklenmelidir? sevdiğini en etkinliği belirtir.

When examining the student response coded as Ö101 in Table 6, it is seen that the research question was not formulated as it should have been in the survey. It was evaluated as insufficient because it used statements containing instructions instead of questions. The student with code Ö99 was evaluated as intermediate because they created a question that was incomplete and unclear. The student with code Ö119 was evaluated as advanced because they created a question that required respondents to answer according to their interests.

It is seen that gifted students mostly performed at an intermediate level on the graph creation question (SR1-c). Eleven percent of the students were rated as inadequate, 87.3% as intermediate, and 5.3% as advanced. In most of the responses from students in the intermediate category, scaling errors were made and the graph was not named. However, there are also responses from students rated as advanced. An example of a response rated as advanced is shown in Figure 2.

Figure 2

Student response in the advanced category regarding graph creation



Upon examining the student's response in Figure 2, it was classified as advanced because the student selected an appropriate graph to reflect the data, labeled the graph's axes, paid attention to scaling, and named the graph.

Some gifted students are able to make correct inferences in questions by using their statistical reasoning and proportional thinking skills. Question SR4 is another question that students perform

poorly on and find difficult to answer. However, there are also students who answer this question at an advanced level. Figure 3 shows an example of a student's response.

Figure 3

Student response in the advanced category related to graph interpretation and inference

Bir doğa bilimci birinci yıldan ikinci yıla kadar ağa takılan buzul balinalarının sayısındaki değişimin kambur balinaların sayısındaki değişime göre daha endişe verici olduğunu açıklamıştır. Grafikteki verilere dayalı olarak doğa bilimcinin buzul balinalar hakkındaki bu endişesinin nedenini nasıl açıklarsınız?

Ağa takılan buzul balina sayısı 5'ten 11'e çıkmıştır.
Bu veri bize ağa takılan buzul balina sayısının 2 katından
daha fazla arttığını göstermektedir. Kambur balina sayısı
ise 1 kat bile artmamıştır. Bu sebeple doğa bilimciler
buzul balinalardaki artışa daha çok endişelenmiştir.

17.3% of students answered this question at an advanced level by using proportional reasoning skills. Examining the student's answer in Figure 3, it can be seen that they established a proportional relationship when making comparisons: "The number of whales caught in nets has increased from 5 to 11. This data shows us that the number of whales caught in nets has more than doubled. The number of humpback whales, however, has not even doubled." For this reason, the student's response has been evaluated in the advanced category.

Findings Regarding Differences in the Statistical Reasoning Levels of Gifted Students According to Grade Level

Before determining whether the scores of gifted students on LOCUS questions differed significantly according to the class level variable, the homogeneity of the variances of the distributions was examined. The results of Levene's test are presented in Table 7.

Table 7

Levene's Test Results for the Scores of Gifted Students on the LOCUS Questions According to Grade Level

| | F | p |
|---|------|------|
| Average Scores of Students on LOCUS Questions | .117 | .890 |

*p < .05

Table 7 shows that the variances of the averages of the scores obtained by gifted students on the LOCUS questions are homogeneous across grade levels.

To test whether the differences in the scores students received on the LOCUS questions according to grade level were significant, a one-way analysis of variance (ANOVA) was performed. The results of the analysis of variance of the scores students received on the LOCUS questions according to grade level are presented in Table 8.

Table 8

Results of One-Way Analysis of Variance for Scores on LOCUS Questions of Gifted Students According to Grade Level

| Grade Level | N | \bar{X} | SD | Source of Variation | SS | df | MS | F | p | η^2 | Significant Difference |
|-------------|-----|-----------|------|---------------------|-------|-----|------|-------|------|----------|------------------------|
| 6th Grade | 52 | .391 | .200 | Between-Groups | .669 | 2 | .335 | 7.830 | .001 | .096 | 6th Grade-7th Grade |
| 7th Grade | 52 | .512 | .205 | Within-Groups | 6.282 | 147 | .043 | | | | 6th Grade-7th Grade |
| 8th Grade | 46 | .547 | .214 | Sum. | 6.951 | 149 | | | | | |
| Total | 150 | .481 | .215 | | | | | | | | |

* $p < 0.05$

Table 8 shows that as the grade level increases from 6th to 8th grade, the average scores of gifted students on the LOCUS questions related to statistical reasoning skills increase. The group with the highest average score on the LOCUS questions was the 8th grade ($\bar{x} = .547$), while the group with the lowest average score was the 6th grade ($\bar{x} = .391$). However, according to the calculated average scores, it was determined that the statistical reasoning of gifted students was at a "Low" level in all grade levels. The scores of gifted students on the LOCUS questions showed statistically significant differences according to grade level ($F(2-147) = 7.830, p < 0.05$). A Post-Hoc Tukey HSD test was performed to determine which group or groups accounted for the difference. According to the Tukey HSD test results, there is a significant difference between the scores of gifted 6th grade students and gifted 7th and 8th grade students on the LOCUS questions ($MD = -.12063^*$, $MD = -.15582^*$, $p < 0.05$, Table 8). The mean scores of gifted 6th grade students on the LOCUS questions ($\bar{x} = .391$) were lower than the means of 7th grade ($\bar{x} = .512$) and 8th grade ($\bar{x} = .547$) students. This indicates that gifted students in grades 7 and 8 have better statistical reasoning skills than gifted students in grade 6. The differences between the other grades were not found to be statistically significant ($p > 0.05$). As a result of the calculations, it can be said that the effect size has a medium to large effect. The calculated effect size shows that the grade level explains approximately 9.6% of the scores that gifted students received on the LOCUS questions.

Findings Regarding Differences in the Statistical Reasoning Levels of Gifted Students According to Their Parents' Educational Status

The Kruskal-Wallis test, a non-parametric test, was used to examine whether the differences in the scores of gifted students on the LOCUS questions were significant according to the educational status of their parents. The analysis results are presented in Table 9.

Table 9

Analysis Results of the Kruskal-Wallis Test for the Scores of Gifted Students on LOCUS Questions According to Their Parents' Educational Status

| Variable | Categories | N | Rank Mean | χ^2 | df | p | η^2 |
|---------------------------|-------------------------|----|-----------|----------|----|---|----------|
| Mother's Education Status | Primary school graduate | 12 | 80.21 | | | | |
| | High School Graduate | 21 | 84.52 | | | | |
| | University Graduate | 84 | 73.25 | | | | |

| | | | | | | | |
|---------------------------|----------------------------------|----|-------|-------|---|------|---------|
| | Master's/Doctorate Degree Holder | 33 | 73.70 | 1.352 | 3 | .717 | - ,0113 |
| Father's Education Status | Primary School Graduate | 8 | 69.31 | | | | |
| | High School Graduate | 22 | 77.39 | | | | |
| | University Graduate | 88 | 75.28 | .223 | 3 | .974 | -.019 |
| | Master's/Doctorate Degree Holder | 32 | 76.34 | | | | |

When Table 9 is examined, it is seen that there is no statistically significant difference between the scores of gifted students on the LOCUS questions according to their mother's educational status ($X^2 = 1.352$; $df=3$; $p=.717$; $p > 0.05$). There is no statistically significant difference in the scores of gifted students on the LOCUS questions according to the father's educational status ($X^2 = .223$; $df=3$; $p=.974$; $p > 0.05$). The calculations show that the effect size is very small, close to zero, for both the mother's and father's educational status.

Discussion, Conclusions, and Recommendations

This study revealed that the statistical reasoning levels of gifted students were below expectations ($\bar{x} = .4812$). The fact that 61.33% of gifted students answered the LOCUS questions in the inadequate category supports this finding. This result is consistent with the findings of Batur and Baki (2022), who reported that high school students had low statistical reasoning levels ($\bar{x} = .483$). The results of the present study are also consistent with those reported by Durak and Tutak (2019) and Ko (2012, 2013). These studies indicate that gifted students, despite their superior abilities in mathematics, do not perform well in statistical reasoning (Durak & Tutak, 2019; Ko, 2012, 2013). It has been found that they perform below expectations on statistical reasoning tasks requiring contextual interpretation and struggle with topics such as sampling distributions and variability modeling.

Sak (2017) states that gifted students demonstrate advanced performance compared to their peers in cognitive areas such as language development, motivation, perception, learning speed, abstract thinking, problem solving, and establishing cause-and-effect relationships. The present study reveals that, despite gifted students' advanced abilities in cognitive and analytical domains, they experience difficulties in formulating statistical research questions that require statistical reasoning, collecting and organizing data, analyzing data, and drawing conclusions. These results support the notion that statistical reasoning requires cognitive processes distinct from general mathematical ability. Garfield et al. (2003) emphasize that the statistical reasoning process, unlike mathematics, requires the ability to understand and explain statistical processes and to interpret statistical results. While mathematics focuses primarily on calculations, rules, procedures, and abstract structures, statistics considers context and variability. Moreover, whereas solutions to mathematical problems are definite, statistical problems involve uncertainty and rely on estimation (Bargagliotti et al., 2020). The lower-than-expected statistical reasoning levels of gifted students may therefore be explained by the fact that statistical reasoning requires different cognitive abilities.

Another noteworthy finding of the study is that gifted students struggled with questions related to graph interpretation and inference (SR2-a, SR2-b, SR2-c, SR3-b, SR3-c). This result is consistent with the findings of Koparan and Güven (2013, 2014) and Batur and Baki (2020), who reported similar difficulties among typically developing students, but differs from the findings of Bayrak (2024), who found that students performed better in analyzing and interpreting data. Questions related to graph

interpretation and inference correspond to the stages of data analysis and conclusion drawing in the statistical research process. Successfully answering questions at this level requires the use of higher-order thinking skills, such as analysis and critical thinking. Gifted students' difficulties with these questions may be attributed to insufficient proficiency in applying higher-order thinking skills in statistical contexts.

In addition, the current study found that gifted students performed at an "average" level in identifying the problem situation (SR1-a), selecting appropriate tables and graphs (SR1-c), reading tables and graphs (SR1-d), and creating graphs (SR3-a). These findings are consistent with those of Batur and Baki (2022), but differ from the results reported by Koparan and Güven (2013, 2014), who found that gifted students performed at the first level in data organization and reduction and data representation. In the study conducted by Durak and Tutak (2019), gifted students scored significantly higher than typically developing students in correctly reading two-way tables, a finding that parallels the results of the present study. Overall, the findings indicate that gifted students are successful in tasks requiring basic statistical knowledge but experience difficulties with tasks requiring more complex statistical reasoning.

The study also found that students' statistical reasoning levels increased as they progressed from sixth to eighth grade. However, further analyses were conducted to determine whether this increase was statistically significant. The results showed that the mean LOCUS scores of sixth-grade students ($\bar{x} = .391$) were significantly lower than those of seventh-grade ($\bar{x} = .512$) and eighth-grade students ($\bar{x} = .547$). No significant difference was found between the mean LOCUS scores of gifted seventh- and eighth-grade students. This finding is consistent with Koparan and Güven (2013, 2014), who reported that development in statistical thinking accelerates between sixth and seventh grades, but it differs from Koparan and Güven (2014), who found significant differences across all grade levels. Watson and Kelly (2008) reported a medium effect size difference between third and fifth graders on sampling-related questions, a small effect size difference between fifth and seventh graders, and no significant difference between seventh and ninth graders, supporting the findings of the present study. Yolcu (2014), however, reported no significant differences in students' statistical reasoning levels across grade levels.

The difference observed between sixth-grade students and students in higher grades may be explained by the increase in conceptual knowledge as grade level increases. However, once foundational concepts are learned, statistical reasoning levels among upper-grade students (seventh and eighth grades) may remain similar. Additionally, due to the spiral structure of the mathematics curriculum, seventh- and eighth-grade students may possess similar levels of basic statistical knowledge. Furthermore, preparation for high school entrance examinations may limit opportunities for students to engage deeply with topics such as statistics. These factors may explain the lack of a significant difference in statistical reasoning levels between gifted seventh- and eighth-grade students.

The present study also examined gifted students' statistical reasoning levels in relation to their parents' educational status. The results indicated no significant differences in gifted students' LOCUS scores based on parental education level. A review of the literature revealed no studies directly examining the statistical reasoning levels of gifted students with respect to parental education status. However, Çanakçı and Özdemir (2015) examined the relationship between students' mathematics achievement and parental education levels and found a significant relationship between these variables. This finding differs from the results of the present study. The lack of a relationship in the current study may be explained by the influence of factors such as gifted students' advanced analytical thinking skills, the differentiated supplementary education they receive at BİLSEM and their schools, and their individual curiosity for learning, which may overshadow the effect of parental education.

In conclusion, the majority of studies in the literature have focused on the statistical reasoning skills of typically developing students (Aoyama & Stephens, 2003; Batur & Baki, 2022; Bayrak, 2024; Güray et al., 2019; Güven et al., 2015; Karaca & Ay, 2025; Koparan & Güven, 2013, 2014; Koparan et al., 2014; Mooney, 2002; Öz, 2019; Öztürk Zora & Anapa Saban, 2023; Yolcu, 2012, 2014). Existing research on gifted students has generally focused on mathematically gifted individuals and compared their statistical reasoning skills with those of typically developing students (Durak & Tutak, 2019; Ko, 2012, 2013). In contrast, the present study examined the statistical reasoning skills of gifted students based on reasoning proficiency levels (low, medium, advanced) and variables such as grade level and parental education status.

Furthermore, students' statistical reasoning skills were analyzed according to the steps of the statistical research process outlined in the GAISE II report (Bargagliotti et al., 2020), identifying the steps students found most challenging and those they found relatively easier. Unlike previous studies that examined statistical reasoning levels across grade levels among typically developing students (Koparan & Güven, 2013, 2014; Watson & Kelly, 2008), this study investigated how these patterns manifest among gifted students. By examining multiple variables simultaneously, this study contributes to the limited body of research on gifted students' statistical reasoning skills.

The findings indicate that differentiated statistics education programs are needed to support gifted students in realizing their full potential. Accordingly, several recommendations are offered for educators, curriculum developers, and policymakers.

Program Development

- Enriched programs designed for gifted students should place particular emphasis on statistical reasoning activities, especially during the elementary and middle school years.
- Activities involving graph reading, interpretation, and inference should be emphasized.
- Statistical concepts should be presented in a gradual and hierarchical manner appropriate to different grade levels.

Teaching Methods and Approaches

- Statistical problem-solving activities should be incorporated to promote the development of higher-order thinking skills.
- Problems should be drawn from real-life contexts and be meaningful to students.
- Problem-based or project-based instructional approaches may be used to enhance statistical reasoning skills.
- Greater emphasis should be placed on higher-order thinking skills, such as graph interpretation and inference, by utilizing technology for computation and graphing tasks.

Teachers' Professional Development

- Teachers are encouraged to participate in in-service training to improve both their content knowledge and their use of technology in teaching statistical topics.

Recommendations for Practitioners and Researchers

- Developing the statistical reasoning skills of gifted students is critically important. Future research may employ experimental or mixed-method designs to examine the effectiveness of interventions aimed at improving these skills.

- As the present study considered grade level and parental education status as independent variables, future studies may explore additional demographic variables such as gender, school type, and the type of program attended at BİLSEM.
- Since this study focused on gifted students at the middle school level, similar research could be conducted with gifted students at the elementary school level.

Limitations

The most important limitation of the study is that it was conducted with students studying at two Science and Art Centers located in the Çiğli and Bornova districts of Izmir. The study was conducted with a study group without determining the population-sample. Therefore, the findings obtained in the study cannot be generalized to all gifted students. However, the Science and Art Centers selected for the study are the oldest and most established institutions in Izmir. These two BİLSEMs were chosen because they have a high number of students and because the families come from different socio-economic levels and have different educational backgrounds. However, for future studies, it is recommended that data be collected from a larger universe and sample to increase the generalizability of the findings.

Disclosure Statements

This research was conducted with permission granted by the Istanbul University-Cerrahpaşa Social and Human Sciences Scientific Research and Publication Ethics Committee in accordance with its meeting decision dated 07.01.2025 and numbered 2025/21.

Conflict of Interest

As authors, we declare that there is no financial or non-financial conflict of interest that could influence this study.

CRedit Authorship Contribution Statement

All authors contributed equally to this study.

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