(ISSN: 2602-4047)

Bal Sezerel, B., Bozbey Esmeroğlu, S. & Ateşgöz, N. N. (2023). The Impact of Gender and Grade Level on Students' General Intelligence, Verbal Potential, Visual Potential, and Memory Capacity, *International Journal of Eurasian Education and Culture , 8(22), 1625-1648.*

DOI: http://dx.doi.org/10.35826/ijoecc.738

Article Type: Research Article

THE IMPACT OF GENDER AND GRADE LEVEL ON STUDENTS' GENERAL INTELLIGENCE, VERBAL POTENTIAL, VISUAL POTENTIAL, AND MEMORY CAPACITY

Bilge BAL SEZEREL
Asst. Prof., Anadolu University, Eskisehir, Turkey, bilgbal@gmail.com
ORCID: 0000-0001-7262-3563

Selin BOZBEY ESMEROĞLU
Res. Asst., Anadolu University, Eskisehir, Turkey, bozbeyselin@gmail.com
ORCID: 0000-0001-8063-4051

Nazmiye Nazlı ATEŞGÖZ
Asst. Prof., Anadolu University, Eskisehir, Turkey, nazmiyeozdemir@gmail.com
ORCID: 0-0001-5944-937X

Received: 03.01.2023 *Accepted: 18.08.2023* *Published: 01.09.2023*

ABSTRACT

This study investigates the impact of gender and grade level on students' general intelligence, verbal potential, visual potential, and memory capacity. The participants of the study consist of 4063 students who applied Anadolu University Center for Research and Practice for High Ability Education (EPTS) for intelligence test administration between the years 2017 and 2021. Of the total sample 2250 were male, 1813 were female. On the other hand, of the sample 1224 were preschool students, 1879 were primary school students and 960 were secondary school students. To determine the students' general intelligence, verbal potential, visual potential and memory capacity, Anadolu Sak Intelligence Scale (ASIS) was used. ASIS is the first intelligence test developed, standardized and normed in Turkey. To examine the impact of gender and grade level on students' general intelligence index (GIQ), verbal potential index (VEPI), visual potential index (VIPI), and memory capacity index (MCI), 2x3 ANOVA was carried out. The results showed that the joint interaction of gender and grade level variables significantly impacts all index scores except for VIPI ($p<.05$). In other words, gender and grade level variables together are determinants of GIQ, VEPI, and MCI scores. In conclusion, this study reveals that males and females exhibit differences in specific cognitive abilities. Furthermore, it is noteworthy that the averages of primary school students are lower than the averages of preschool students in general intelligence and in each of the indices (VEPI, VIPI, MCI). As a result of this study, males and females in different grade have different advantages.

Keywords: Gender, grade, general intelligence, verbal potential, visual potential and memory capacity.

INTRODUCTION

Factors influencing intelligence have captured the interest of both society and researchers in the fields of education and psychology (Neisser et al., 1996; Nisbett et al., 2012). These factors are primarily attributed to gender, the complex interplay of children's inherent predispositions, the effects of formal education, and contextual factors within the school environment (Ceci & Williams, 1997; Christian et al., 2001; Eccles & Roeser, 2012; Mayer, 2000). Gender-dependent variations in intelligence levels between females and males are contingent upon how intelligence is conceptualized and measured. On the other hand, the variations in intelligence levels across different grade levels are linked to the cognitive and academic skill development fostered by education. Thus, the examination of the relationship between intelligence and factors such as gender and grade level constitute the focus of this research.

Numerous academic studies have investigated the relationship between grade level and general cognitive ability as well as academic achievement (Boulanger, 1981; Fleming & Malone, 1983; Steinkamp & Maehr, 1983). As grade levels progress, the accumulation of academic knowledge increases, leading intelligence to be considered the strongest predictor of academic success (Gottfredson, 2002; Kuncel et al., 2004; Rosander et al., 2011; Taub et al., 2008). Laidra et al. (2007) emphasized a causal relationship between intelligence and achievement, revealing that the most powerful predictor of success at all levels of students is their general cognitive ability. On the other hand, Brody (1993) and Jensen (1998) indicated that the predictive value of general cognitive ability for school success varies across different grade levels. Jensen (1998) demonstrated that from primary school to high school, undergraduate, and even graduate levels, there is a diminishing correlation between intelligence levels and school grades. This is attributed to an increase in individuals who were considered academically unsuccessful dropping out of school in later years, resulting in a decrease in the variance related to general intelligence. Consequently, at higher grade levels, there exists a lower correlation between school achievement and general intelligence.

Studies related to intelligence often include gender comparisons. In fact, the earliest studies on gender differences in intelligence focused on comparing intelligence scores between genders. Initially, the belief that men had larger brain volumes than women led to the assumption that men were more intelligent. However, this belief gradually shifted towards the idea that intelligence would vary based on differences in brain processing (Hyde, 2005). Over time, these assertions underwent changes and became one of the most debated topics, especially in the early 21st century. Currently, there are studies that claim no significant difference in general intelligence based on gender (Halpern & LaMay, 2000; Savage-McGlynn, 2012), while there are also studies asserting gender-based differences in intelligence (Jackson & Rushton, 2006; Nyborg, 2005; Sánchez et al., 2007). On the other hand, researchers who argue that there are gender differences in certain cognitive abilities that contribute to general intelligence have obtained results that favor both women and men (Hyde, 2005; Lynn et al., 2002).

Colom and García-Lopez (2002) challenged the claim that intelligence remains unchanged based on gender (Allika et al., 1999; Hattori & Lynn, 1997; Lynn, 1994; 1998). In their studies, they indicated that men tend to have higher general IQ scores compared to women, and they demonstrated gender differences in cognitive abilities such as knowledge, reasoning, and spatial skills. Van der Sluis et al. (2006) investigated whether the observed gender differences in the subtests of the WAIS-III intelligence test were associated with the gender difference in general intelligence. According to their findings, men outperformed women in three out of ten subtests, namely the general knowledge subtest that evaluates verbal comprehension skills, the arithmetic subtest that assesses working memory by testing concentration, and the matrix reasoning subtest that assesses problem-solving and inductive reasoning. On the other hand, women performed better than men only in the symbol search subtest that evaluates processing speed. Johnson and Bouchard (2007) compared 436 participants (188 males, 248 females) aged 18 to 79 and found that there was a very small gender difference in general cognitive ability. However, they noted that men performed better in visual-spatial tasks, while women performed better in verbal language and perceptual speed tests. As seen, studies aiming to compare general intelligence based on gender also approach intelligence from different dimensions.

In intelligence assessments, one of the sub-dimensions considered with respect to gender is verbal ability. Verbal ability is associated with crystallized intelligence, encompassing verbal comprehension, general knowledge, language development, vocabulary, and knowledge and skills acquired through life experiences (Sak et al., 2016). In studies that focus on gender-based comparisons of verbal ability, it is frequently suggested that females possess higher verbal abilities compared to males (Anderson, 2004; Bartholomew, 2004; Galsworthy et al., 2000). A meta-analysis conducted by Hyde and Marcia (1988) revealed that the superiority of females in verbal abilities varies based on age and type of ability. In reading comprehension, primary school-level females outperformed males, but this difference did not remain significant in later age groups. Regarding vocabulary, females between the ages of 6-10 displayed better performance than males, while no significant difference was observed within the 11-18 age range. The analysis of gender differences according to ability type indicated that females demonstrated higher average abilities in verbal fluency and anagrams. On the other hand, males exhibited better performance in analogies compared to females. However, differences in reading comprehension, composition writing, and vocabulary were not significant. Thus, gender differences in verbal abilities vary depending on the specific ability type. While males tend to excel in verbal analogies (Colom et al., 2004), females tend to outperform males in natural language abilities, reading, and writing (Stoet & Geary, 2013).

Another sub-dimension, spatial visual ability, represents fluid intelligence and spatial relations. Fluid intelligence includes capacities such as detecting relationships, making inferences, categorizing, generalizing, hypothesis formation, and inductive thinking. Spatial skills, on the other hand, are defined as the ability to understand relationships between features and attributes, as well as between objects and empty spaces, including transformations in two or more dimensions (Levine et al., 2012). Visual spatial skills consist of subcomponents such as spatial visualization, mental rotation, spatial orientation, and spatial perception (Mix & Cheng, 2012). Studies consistently reveal gender differences in children's visual spatial skills. Research conducted from the age of four onward suggests that male children exhibit superior visual spatial abilities (Levine et al., 1999) and perform better than females in various visual-spatial tasks compared to females (Jansen et al., 2013; Jirout & Newcombe, 2015).

Another frequently studied sub-dimension related to gender is memory capacity. The most significant potential area considered under memory capacity is working memory. There is a strong correlation between working memory, academic achievement, and learning (Dehn, 2014). Studies investigating the relationship between memory test scores and gender in children and adolescents have produced various results (Aliotti & Rajabiun, 1991; Robinson et al., 1996; Temple & Cornish, 1993; Ullman et al., 1997). Temple and Cornish (1993) evaluated gender differences in verbal memory tasks among 64 males and 64 females aged 9 to 21. They found that females outperformed males in the verbal memory task. In another study examining gender differences, Robinson et al. (1996) demonstrated that males in preschool scored higher on visual-spatial working memory tasks than females. Conversely, Aliotti and Rajabiun (1991) and Ullman et al. (1997) found no significant relationship between gender and memory performance in their research.

When considering intelligence-based studies conducted with respect to class level and gender variables, it is evident that diverse outcomes are observed. An examination of the literature reveals that varying findings emerge based on gender and grade level (preschool, primary school, secondary school, high school) variables. Therefore, in order to comprehensively address the source of this variability, empirical studies employing different intelligence scales and diverse samples are needed. Thus, evaluating students within a broad grade level (preschool, primary school, and secondary school) in the context of these mentioned skills will provide significant insights for student identification and educational needs.

METHOD

This study aimed to investigate whether gender and class level have an impact on students' general intelligence, verbal potential, visual potential, and memory capacities. For this purpose, the study utilized a correlational survey model. The correlational survey model explores the outcomes of existing differences in variables without intervening in those variables (Fraenkel et al., 2019).

Participant

The participants of the study consisted of 4063 students who underwent intelligence testing at Anadolu University Center for Research and Practice for High Ability Education (EPTS) in Eskişehir. Of the participants who applied to the center for identification, 297 (7% of the whole sample) came from different provinces (Amasya, Bilecik, İzmir, Ankara, Afyon, NewYork, Ağrı, İstanbul, Sinop, Kastamonu, Muş, Çorum, Kütahya, Bursa, Samsun, Tekirdağ, Adana, Kocaeli, Burdur, Yalova, Diyarbakır, Konya, France, Maraş, Trabzon, Manisa, Hatay, Gaziantep, Mardin, Zonguldak, Erzincan, Balıkesir, Kocaeli, Şanlıurfa). In the EPTS, a team of experts administered intelligence test to identify students.

In this study, convenience sampling method, one of the non-probability sampling approaches, was used to determine the participants. In the convenience sampling method, the researcher reaches the participants in a short period of time in economical and easy ways (Christensen et al., 2015). Accordingly, all students between the ages of 48 and 155 months who applied to the EPTS between 2017 and 2021. The 21 practitioners working at the center conducted intelligence test applications for 5 years. Table 1 represents information about the participants' grade and gender variables.

Table 1. Information on Participants' Grade Level and Gender Variables

	Gender		
Grade	**Male**	**Female**	**Total**
Preschool	735	489	1224
Primary	992	887	1879
Secondary	523	437	960
Total	**2250**	**1813**	**4063**

Instrument

To measure general intelligence, verbal potential, visual potential, and memory capacities of the participant, Anadolu-Sak Intelligence Scale (ASIS) was used. ASIS is the first intelligence test developed, standardized and normed in Turkey (Sak et al., 2016). This intelligence test is administered individually for ages 4 years 0 month to 12 years 11 month 30 days. The ASIS was developed based on the Cattell-Horn-Carroll (CHC) three-layered hierarchical model of intelligence (McGrew, 2009; Schneider & McGrew, 2012). It provides a three-factor solution (Verbal Potential Index-VEPI-, Visual Potential Index-VIPI-, and Memory Capacity Index-MCI-) according to the CHC model. The test also provides an additional two-factor solution for the assessment of intelligence. The two-factor solution provides verbal IQ index and nonverbal IQ index. The General Intelligence Index (GIQ) obtained from the seven subtests of ASIS, the Verbal Intelligence Index (VIQ) derives from the three verbal subtests, and the Nonverbal Intelligence Index (NIQ) derives from the four nonverbal subtests. VEPI and VIPI scores are different from VIQ and NIQ scores. VEPI and VIPI scores don't involve memory subtest scores. On the other hand, VIQ and NIQ scores are obtained from memory subtest scores as well as verbal and nonverbal subtest scores. Every item is evaluated according to being true (1 point) or false (0 point). Then total sore is procured. Finally, score of each subtest is compared with the standardized values. Since the study was conducted within the framework of the three-layered hierarchical model of intelligence, we focused on the skills included in this model. Figure 1 shows the ASIS three-layered hierarchical model of intelligence.

According to three-layered hierarchical model of intelligence, the General Intelligence Index (GIQ) is composed of VEPI, VIPI and MCI. Verbal Potential Index (VEPI) consists of Verbal Analogy (VAN) and Words-Meanings (WOM) subtests. Visual Potential Index (VIPI) is composed of Visual-Spatial Analogy (VISA) and Visual Flexibility (VIF). Memory Capacity Index (MCI) includes Verbal Short-Term Memory (VSTM), Visual Span Memory (VSM), and Visual-Spatial Pattern Memory (VSPM) subtests.

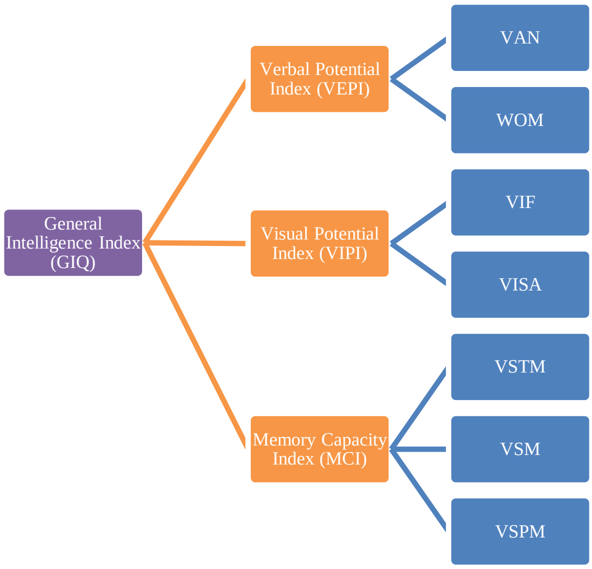

Figure 1. Three-Layered Hierarchical Model of Intelligence

The VEPI component represents crystallized intelligence in the theoretical model. Crystallized intelligence represents verbal comprehension, general knowledge, language development, vocabulary and discipline-specific knowledge acquired and developed in the life cycle. The VIPI component represents the fluent intelligence component. Fluent intelligence encompasses knowledge acquired in the past and skills that do not require learning. It mostly includes skills such as recognizing and understanding relationships, inferring, classifying, generalizing, hypothesizing, predicting, identifying similarities and differences, drawing conclusions and inductive thinking. In the theoretical model, the MCT component includes short-term memory and working memory. Therefore, inferences are made about the data obtained from the index and the information processed and stored.

Since this study investigates whether gender and grade level affect students' general intelligence, verbal potential, visual potential and memory capacity, all subtests will be briefly mentioned. The skills that the subtests aim to measure will also provide information about the index scores in total.

Verbal Analogy (VAN)

The VAN subtest assesses the understanding of language and the ability to reason verbally. The questions in this subsection were created using a theoretical structure-mapping framework (Gentner, 1983; Winston et al., 1987). In analogies involving semantic relations, the structure is "If A and B, what is C?". Subtest items were created by using analogy types such as contrast, classification, similarity, grouping, area-location, whole-part, part-whole and whole-component, phase-process. For example, the tester asks this question “Monkey is an animal, and orange is …?”. The examinee’s answer should be “a fruit”. Although the VAN subtest involves reasoning, it also necessitates vocabulary and general knowledge in order to solve analogy problems.

Words-Meanings (WOM)

The WOM subtest evaluates vocabulary expertise, linguistic progression, sentence comprehension, and the ability to grasp words within their contextual meaning. Vocabulary knowledge at the conceptual level is a prime sign of intelligence and language development and intelligence (Corrigan, 1979). For example, the tester asks this question "John drags one's feet. What is the meaning of drag one's feet, in this sentence?". The examinee should explain the meaning of this idiom.

Visual-Spatial Analogy (VISA)

The VISA subtest was crafted based on the theoretical framework of structure-mapping and a taxonomy of meronymic relations (Gentner, 1983; Winston et al., 1987). The theoretical foundation of VISA is akin to that of the VAN subtest. Unlike the VAN subtest, which incorporates verbal analogies relying on vocabulary knowledge and language development, the VISA subtest focuses on solving visual-spatial analogy problems that do not depend on previous knowledge. It comprises 2x2 and 2x3 matrices, gauging nonverbal inductive reasoning through these analogies. Test-takers are required to discern the interconnections between geometric shapes or figures and then deduce the missing elements within a matrix by analyzing conceptual associations. For instance, if the first row of a 2x2 matrix contains circles and the first cell of the bottom row features a square, the second cell should also contain a square.

Visual Flexibility (VIF)

The VIF subtest assesses visual-spatial aptitude in solving challenges pertaining to perceptual differentiation, resizing, adaptable perception, spatial correlations, mental imagery, and cognitive rotation (Bennett & Warren, 2002; Cooper, 1975; Takano, 1989). This segment comprises two categories of tasks. The first category involves the basic rotation of two-dimensional forms. The participant is tasked with selecting the rotated shape that properly fits into a gap within a larger figure. The second category encompasses the resizing and rotation of two-dimensional forms. The participant is required to identify the appropriately resized and rotated version of a larger shape.

Verbal Short-Term Memory (VSTM)

The VSTM subtest evaluates memory capacity using narrative comprehension. A brief story recall examination assesses short-term memory, as long as it doesn't necessitate delayed recall or repeated exposures (Schneider & McGrew, 2012). This recall segment serves as a test of immediate memory function, in which participants are provided with stimuli and subsequently, after an approximately 50-second interval, questioned by the examiner. Directly following the reading of the story, the examiner poses verbal inquiries regarding the narrative. The child is expected to recollect processes, events, and specific details including time, colors, numbers, names, quantities, and locations.

Visual Span Memory (VSM)

The VSM subtest gauges working memory, visual span memory, and sequential processing abilities. It evaluates the aptitude to input data, sustain active retention in primary memory, and promptly reproduce stimuli in the precise sequence they were presented (Schneider & McGrew, 2012). Maintaining the sequential arrangement is a pivotal skill for various cognitive tasks (Baddeley, 2012). The evaluator presents shapes (such as stars, squares, triangles, etc.) in a designated sequence along a line for a duration of 5 seconds. Subsequently, the participant is prompted to recollect the accurate sequence from a set of alternatives, all within a 30-second timeframe.

Visual-Spatial Pattern Memory (VSPM)

The VSPM subtest evaluates the capability of visual-spatial short-term memory. This subsection comprises two distinct item types. The initial type necessitates the recollection of figures or patterns created from triangles on a grid of various dimensions such as 2x1, 2x2, 2x3, 3x3, and so on. It is imperative to accurately recall both the shape itself and its specific position on the grid. The assessor displays the stimuli for a duration of 5 seconds and subsequently requests the identification of the correct solution among multiple options, all within a 30-second timeframe. The second type involves spatial elements, encompassing dots situated on or between two, three, or four lines. The examinee is required to memorize the dot locations to accurately select the appropriate option.

Technic qualities of ASIS

ASIS stands as a dependable and substantiated instrument for assessing intelligence. Its reliability and validity have been extensively demonstrated through several research studies, affirming its technical qualities. During the developmental phase of ASIS, a pilot study encompassing 1202 children aged 4 to 12 was undertaken, while a standardization study was conducted with 4641 children from various regions of Turkey (Sak et al., 2016). Researchers documented that internal consistency coefficients for ASIS subtests' reliability ranged from .81 to .94 within the norm sample. The reliability coefficients for General IQ, Verbal IQ, and Visual IQ were reported as 0.99, 0.99, and 0.97, respectively. In a separate investigation, test-retest reliability and interrater reliability were evaluated (Tamul et al., 2020). The test-retest reliability values exhibited a range of .89 to .95, while intercoder reliability values spanned from .91 to 1.00. Taken together, the reliability research findings indicate that ASIS consistently and reliably measures intelligence, making it a robust intelligence assessment tool.

To assess the validity of ASIS, multiple dimensions including construct validity, criterion validity, social validity, and discrimination validity were investigated. Construct validity was evaluated through explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) to explore the underlying structure of ASIS. EFA was initially carried out with a pilot study involving 679 children (Sak et al., 2016). The EFA findings indicated that ASIS could be conceptualized with either a two-factor or a three-factor model. These models were tested, with the first employing a two-factor solution (verbal intelligence and nonverbal intelligence), and the second adopting a three-factor solution (short-term memory, fluid reasoning, and crystallized knowledge). The two-factor solution accounted for 54.78% of the total variance, while the three-factor solution explained 65.51% of the total variance. Subsequently, CFA was conducted using a norm sample, confirming the presence of both models. The three-factor model exhibited slightly superior fit statistics, including higher NNFI and CFI values. The RMSEA was calculated as .067 for the two-factor model and .060 for the three-factor model, while the SRMR statistics were .017 and .014, respectively. Based on these fit indices derived from CFA, it can be inferred that both models adequately represent the data. In conclusion, these analyses collectively substantiate the theoretical construct of ASIS.

A study concerning the criterion validity of ASIS demonstrated significant correlations between its scores and school grades, with correlation coefficients ranging from .57 to .83 (Sak et al., 2019). Another study, conducted by Dülger (2018), compared ASIS scores with scores from the UNIT and the RIAS assessments. The reported coefficients varied from .50 to .82, further supporting the criterion validity of ASIS. In terms of social validity, a study by Tamul et al. (2020) revealed that ASIS achieved an exceptionally high level of social validity, indicating its acceptance and relevance within its intended context. The discrimination validity of ASIS was also explored. ASIS scores among children diagnosed with intellectual disability, autism spectrum disorder, attention deficit hyperactivity disorder, learning disability, and giftedness were found to align with their respective formal diagnoses (Cırık et al., 2020; Sözel et al., 2018). This suggests that ASIS is capable of differentiating between various cognitive profiles, further establishing its validity as an intelligence assessment tool. In summary, the gathered evidence collectively demonstrates that ASIS is a dependable and valid instrument for measuring intelligence across multiple dimensions, including criterion, social, and discrimination validity.

Data Collection and Data Analysis

In this study, data were collected from 4063 students. The data were obtained from children who apply to Anadolu University Center for Research and Practice for High Ability Education (EPTS) between 2017 and 2021 for intelligence testing. A total of 21 practitioners administered the tests in 2 different test rooms of the center. The practitioners were experts who were involved in the development of ASIS. Depending on a child’s age and test performance, the average testing time ranges from 20 to 45 minutes for the full battery. Within the scope of the study, firstly, descriptive findings of the participants' GIQ, VEPI, VIPI and MCI scores were analyzed. Then, it was investigated whether gender and grade level variables had an impact on the index scores. For this purpose, two-factor ANOVA was conducted for independent groups. Thus, it was investigated whether there was a significant difference in index scores according to independent variables. Normality and linearity assumptions were examined for 4 different dependent variables according to the level of each independent variable. In the normality assumption analysis, kurtosis and skewness values were found to be within ±1 limits. In addition, the linearity assumption was obtained by examining the residual graph in the regression analysis and it was seen that the data were on a linear line.

FINDINGS

Descriptive Findings

Table 2 shows the descriptive statistics of the participants' GIQ (General Intelligence Index), VEPI (Verbal Potential Index), VIPI (Visual Potential Index) and MCI (Memory Capacity Index). When Table 2 is examined, the participants' scores on the general intelligence index ranged between 39 and 156. The mean score is 106.04 (ss= 18.4089). While the mean scores of the participants' GIQ values and VEPI scores were the same, the mean score of VIPI was the highest among the other index score averages, and the mean score of MCI was the lowest.

Table 2. Descriptive Findings

N = 4063	Minimum	Maximum	$\bar{X}$	sd
GIQ	39	156	106.04	18.089
VEPI	40	160	106.04	15.974
VIPI	40	160	108.62	17.255
MCI	47	158	101.78	17.361

The Impact of Gender and Grade Level Variables on Index Scores

The study investigated whether gender and grade level affect students' general intelligence, verbal potential, visual potential and memory capacity. For this purpose, GIQ, SPE, GPE and BKE index mean scores were tested with 2x3 ANOVA according to the independent variables of gender and grade level.

The Impact of Gender and Grade Level Variables on Index Scores

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The impact of gender and grade level variables on GIQ

In this study a two-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of gender and grade level on GIQ, as a measured by the ASIS. Descriptive statistics for participants' GIQ scores are presented in Table 3, ANOVA results are provided in Table 4, and post hoc test values are presented in Figure 2.

Table 3. Descriptive Statistics for Participants' Gender and Grade Level

N=4063	Male		Female		Total	
Grade	$\bar{X}$	sd	$\bar{X}$	sd	$\bar{X}$	sd
Preschool	109.65	18.798	106.60	17.593	108.43	18.380
Primary	102.01	16.359	102.26	15.509	102.12	15.960
Secondary	110.76	20.764	110.57	18.926	110.67	19.938
Total	106.54	18.700	105.43	17.286	106.04	18.089

Table 4. ANOVA Results of GIQ Scores According to Gender and Grade Level

Source	Sum of Squares	df	Mean Square	F	p<	η_p^2
Gender	916.978	1	916.978	2.929	.087	.001
Grade Level	54039.725	2	27019.862	86.318	.000**	.041
Gender*Grade Level	2082.855	2	1041.427	3.327	.036*	.002
Error	1269951.984	4057	313.027			
Total	47019381.000	4063				

*p<.05 **p<.001

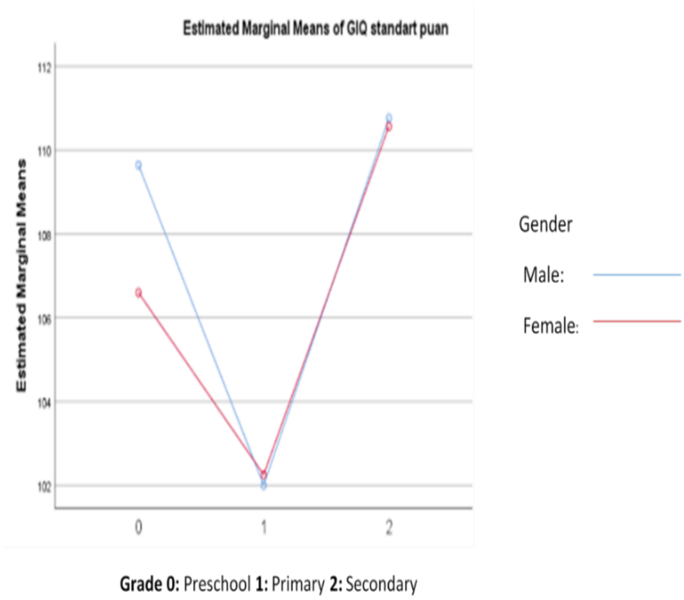


Figure 2. Estimated Marginal Means of GIQ

There was a statistically significant main effect for gender and grade level on GIQ (F (2,4057) =3.327; p=.036) as seen in Table 4. However, the effect size was small (η_p^2= .002). The graph of Estimated Marginal Means of GIQ and the data in Table 3 were analyzed in order to determine the source of the difference created by gender and grade level interactively in GIQ scores. According to Figure 2 and Table 3, it is seen that the averages of males in preschool were higher than females, the averages of females in primary school were higher than males, and the averages of males in secondary school were higher than females. However, the most striking difference between the averages was observed in the GIQ scores of males and females in preschool.

On the other hand, when the data were divided by gender, a one-factor ANOVA post hoc test for independent samples was conducted to determine how the difference in grade level would affect the GIQ scores of females and males. In the analysis, it was found that the averages of males in preschool were significantly higher than those of males in primary school (p<.001), while the averages of secondary school students were significantly higher than those of primary school students (p<.001). The analysis also showed that the averages of females in preschool were significantly higher than those of females in primary school (p<.001), and the averages of secondary school students were significantly higher than those of both preschool (p<.005) and primary school students (p<.001).

The impact of gender and grade level variables on VEPI

In this study a two-way between- ANOVA was conducted to explore the impact of gender and grade level on VEPI, as a measured by the ASIS. Descriptive statistics for participants' VEPI scores are presented in Table 5, ANOVA results are provided in Table 6, and post hoc test values are presented in Figure 3.

Table 5. Descriptive Statistics for Participants' Gender and Grade Level

N=4063	Male		Female		Total	
Grade	$\bar{X}$	**sd**	$\bar{X}$	**sd**	$\bar{X}$	**sd**
Preschool	109.57	17.868	108.47	15.917	109.13	17.117
Primary	101.76	14.168	103.68	13.649	102.67	13.955
Secondary	108.00	17.712	109.54	15.758	108.70	16.859
Total	105.76	16.686	106.39	15.040	106.04	15.974

Table 6. ANOVA Results of VEPI Scores According to Gender and Grade Level

Source	Sum of Squares	df	Mean Square	F	p<	η_p^2
Gender	578.929	1	578.929	2.363	.124	.001
Grade Level	38155.642	2	19077.821	77.870	.000**	.037
Gender*Grade Level	1757.848	2	878.924	3.588	.028*	.002
Error	993949.043	4057	244.996			
Total	46723528.000	4063				

*p<.05 **p<.001

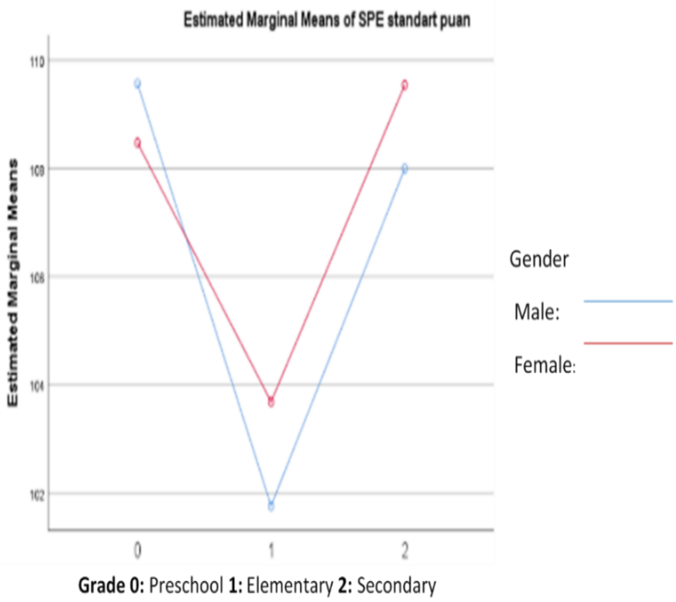


Figure 3. Estimated Marginal Means of VEPI

There was a statistically significant main effect for gender and grade level on VEPI (F (2,4057) =3.588; p=.028) as seen in Table 6. However, the effect size was small (η_p^2= .002). The graph of Estimated Marginal Means of VEPI and the data in Table 5 were analyzed in order to determine the source of the difference created by gender and grade level interactively in VEPI scores. According to Figure 3 and Table 5, it is seen that the averages of males in preschool were higher than females, the averages of females in primary school were higher than boys, and the averages of females in secondary school were higher than males. However, the most striking difference between the averages was observed in the VEPI scores of male and female students in secondary school.

On the other hand, when the data were divided by gender, a one-factor ANOVA post hoc test for independent samples was conducted to determine how the difference in grade level would affect the VEPI scores of females and males. In the analysis, it was found that the averages of males in preschool were significantly higher than those of males in primary school (p<.001), while the averages of secondary school students were significantly higher than those of primary school students (p<.001). The analysis also showed that the averages of females in preschool were significantly higher than the averages of females in primary school (p<.001), and the averages of secondary school students were significantly higher than the averages of primary school students (p<.001).

The impact of gender and grade level variables on VIPI

In this study a two-way between- ANOVA was conducted to explore the impact of gender and grade level on VEPI, as a measured by the ASIS. Descriptive statistics for participants' VIPI scores are presented in Table 7, ANOVA results are provided in Table 8.

Table 7. Descriptive Statistics for Participants' Gender and Grade Level

N=4063	**Male**		**Female**		**Total**	
Grade	$\bar{X}$	**sd**	$\bar{X}$	**sd**	$\bar{X}$	**sd**
Preschool	110.12	17.392	109.19	17.155	109.75	17.297
Primary	106.19	16.078	106.49	16.118	106.33	16.093
Secondary	111.71	19.510	111.61	17.802	111.66	18.742
Total	108.76	17.508	108.46	16.940	108.62	17.255

Table 8. ANOVA Results of VIPI Scores According to Gender and Grade Level

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**p<**	η_p^2
Gender	53.300	1	53.300	.182	.670	.000
Grade Level	19762.580	2	9881.290	33.720	.000*	.016
Gender*Grade Level	271.510	2	135.755	.463	.629	.000
Error	1188874.540	4057	293.043			
Total	49147890.000	4063				

**p<.001

There was not a statistically significant main effect for gender and grade level on VIPI (F (2,4057) =.463; p=.629) as seen in Table 8. On the other hand, while there was no significant difference between the VIPI score averages according to gender (F (1,4057) =.182; p=.670), the grade level variable made a significant difference on the VIPI score (F (2,4057) =33.720; p<.001). According to the multiple comparison results of the one-factor ANOVA post hoc test for independent samples conducted to determine the source of the significant difference between the levels of the grade level independent variable, it was found that the VIPI score averages of preschool students were significantly (p<.001) higher than the averages of primary school students, and the averages of secondary school students were significantly (p<.001) higher than the averages of primary school students.

The impact of gender and grade level variables on MCI

In this study a two-way between- ANOVA was conducted to explore the impact of gender and grade level on MCI, as a measured by the ASIS. Descriptive statistics for participants' MCI scores are presented in Table 9, ANOVA results are provided in Table 10, and post hoc test values are presented in Figure 4.

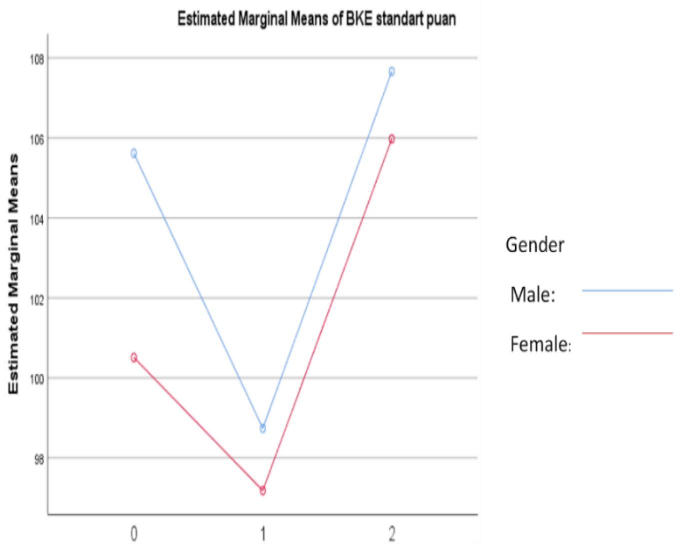
Table 9. Descriptive Statistics for Participants' Gender and Grade Level

N=4063	**Male**		**Female**		**Total**	
Grade	$\bar{X}$	**sd**	$\bar{X}$	**sd**	$\bar{X}$	**sd**
Preschool	105.62	17.858	100.51	17.218	103.58	17.775
Primary	98.74	16.337	97.18	15.133	98.00	15.795
Secondary	107.66	18.651	105.98	17.347	106.90	18.079
Total	103.06	17.825	100.20	16.636	101.78	17.361

Table 10. ANOVA Results of CMI Scores According to Gender and Grade Level

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**p<**	η_p^2
Gender	7157.964	1	7157.964	25.057	.000**	.006
Grade Level	53306.389	2	26653.195	93.303	.000**	.044
Gender*Grade Level	2556.441	2	1278.220	4.475	.011*	.002
Error	1158934.263	4057	285.663			
Total	46723528.000	4063				

*p<.05 **p<.001



Grade 0: Preschool **1:** Elementary **2:** Secondary

Figure 4. Estimated Marginal Means of CMI

There was a statistically significant main effect for gender and grade level on CMI (F (2,4057) =4.475; p=.011) as seen in Table 10. However, the effect size was small (η_p^2= .002). The graph of Estimated Marginal Means of CMI and the data in Table 9 were analyzed in order to determine the source of the difference created by gender and grade level interactively in CMI scores. Figure 4 and Table 9 show that the averages of male students in preschool, primary and secondary schools are higher than those of female students. However, the most striking difference between the averages was observed in the CMI scores of males and females. On the other hand, when the data were divided according to gender, a one-factor ANOVA post hoc test for independent samples was conducted to determine how the difference in grade level would affect males' and females' CMI scores. The analysis result showed that the averages of males in preschool were significantly higher than those of males in primary school (p<.001), while the averages of secondary school students were significantly higher than those of primary school students (p<.001). The analysis also indicated that the averages of females in preschool were significantly higher than the averages of females in primary school (p<.001), and the averages of secondary school students were significantly higher than the averages of both preschool and primary school students (p<.001).

CONCLUSION and DISCUSSION

In this study, it was found that gender and grade level factors have an impact on the General Intelligence Quotient (GIQ) scores. The average scores of male students in preschool were higher than those of female students, the average scores of female students in primary school were higher than those of male students, and in secondary school, the average scores of male students were higher than those of female students. However, the most striking difference in averages was observed between male and female students in preschool in terms of their GIQ scores. On the other hand, when the effect of grade level differences on the GIQ scores of males and females were examined separately, it was observed that the averages of male students in preschool were higher than those of male students in primary school, and the averages of male students in secondary school were even higher than those of male students in primary school. It was also found that the averages of female students in preschool were higher than those of female students in primary school, and the averages of female students in secondary school were higher than those of female students in both preschool and primary school.

In the literature, studies examining the impact of gender differences on intelligence cover various age groups. Studies investigating gender differences in intelligence in children aged between 5 and 17 have generally shown that there is not any significant difference (Keith et al., 2011; Reynolds et al., 2013) or there is a significant difference in favor of females (Härnqvist, 1997; Reynolds et al., 2008; Rosén, 1995). A limited number of studies have provided information about gender differences in children under five years old. Sellers et al., (2002) stated that there was not gender difference in general intelligence for preschool children in the standardization sample of WPPSI-R. In contrast, Burns and Reynolds (1988) discovered that there was a statistically difference in favor of females between the ages of 2 and 4 in the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983). Research conducted on children generally indicates no gender difference or an advantage for girls in terms of general intelligence. Therefore, it can be said that the findings obtained from the study differ from the studies in the literature.

We found that gender and grade level had an impact on the VEPI score. The findings showed that the averages of males in primary school were higher than those of females, the averages of females in primary school were higher than those of males, and the averages of females in secondary school were higher than those of males. However, the most striking difference between the averages was observed in the VEPI scores of male and female students in secondary school. On the other hand, when the impact of grade level difference on the VEPI scores of males and females was examined, it was found that the averages of male students in preschool were higher than those of male students in primary school, and the averages of male students in secondary school were higher than those of male students in primary school. The averages of female students in preschool were higher than those of female students in primary school, and the averages of female students in secondary school were higher than those of female students in primary school.

VEPI scores were composed of Verbal Analogy (VAN) and Words-Meanings (WOM) subtests. This component, which is included as crystallized intelligence in the CHC model, includes verbal comprehension, general knowledge, language development, vocabulary, and discipline-specific knowledge. These skills can be acquired and refined throughout one's life (Schneider & McGrew, 2012). Research findings show that the crystallized intelligence develops in preschool period via teaching conceptual knowledge and in secondary school via experience. Upon entering primary school, it's conceivable that students might undergo a decline in certain areas due to their primary focus on acquiring reading skills. Some studies within the literature corroborate various aspects of the findings in this study. Denno (1982) and Halpern (1986) reported that females have an advantage over males in verbal performance during the primary school years. Although there is no consistent difference in vocabulary between genders at the beginning of school, it is noteworthy that females learn to read earlier and the number of males who need special education in reading programs is high (Maccoby, 1966).

In this study, research findings showed that there was not a statistically significant main effect for gender and grade level on VIPI. VIPI is composed of Visual-Spatial Analogy (VISA) and Visual Flexibility (VIF). Although there was not any significant difference in VIPI score regarding gender, there was a significant difference in VIPI score regarding grade level. It was found that the average VIPI scores of both preschool and secondary school students were higher than those of primary school students. Kotsopoulos et al. (2017) supports these findings. Their study showed that there was not any difference in visual-spatial scores between males and females up to the age of 2, but from the age of 2 onwards, this difference was influenced by environmental and consequently cognitive advantages. The difference in visual-spatial skills between males and females might stem from the rich environmental stimuli provided to them at home. A cross-cultural study conducted by Levine et al. (2005) found that male children from high and middle socioeconomic status families outperformed female children in spatial tasks, whereas there was not any difference between males and females from low socioeconomic status families. Research has indicated that females from higher-income families tend to engage in more spatial activities at home compared to females from lower-income families (Dearing et al., 2012). Therefore, it could be argued that there is no difference in visual-spatial abilities between males and females who have equal conditions. On the other hand, the higher visual potential of preschool students compared to primary school students suggests a link with the scope of early childhood education. Participation in multifaceted and visual activities and playing with such toys are crucial contributions to the development of visual-spatial skills. Activities commonly used in preschool, such as puzzles and block building, have been found to be associated with visual-spatial aspects and to enhance skills such as spatial perception, mental rotation, and spatial visualization (Brosnan, 1998; Verdine et al., 2008)

We found that gender and grade level had an impact on the MCI score. The averages of male students in preschool, primary and secondary schools were higher than those of female students. The most striking difference in the averages of MCI scores between males and females was observed in preschool. On the other hand, the averages of the males in both preschool and secondary school were higher than those of the boys in primary school. Also, the averages of female students in the secondary school were higher than those of both preschool and primary school female students. The averages are lower for both males and females in the primary school period compared to other grade levels. One reason for this may be children's efforts to internalize this situation during this period when the first academic knowledge is acquired. Working memory is directly associated with learning. Basic reading skills, mathematical operations and reasoning are shaped by the effective use of working memory (Alloway, 2009; Dehn, 2014). In the literature, there are studies that support these findings. For example, Longman et al. (2007) indicated that males had scores about 2-3 IQ points higher in the memory index of WAIS-III. Similarly, Cattaneo et al. (2006) reported that males were advantageous in spatial working memory tasks involving high cognitive load. Studies (Postma et al., 1998; Postma et al., 1999) examining gender differences in visuospatial concurrent memory involving object location associations have shown that males outperform females in remembering the location of objects in a given stimulus presentation.

One of the important results of the study is that the averages of primary school students are lower than the averages of preschool students in general intelligence, verbal potential, visual potential and memory capacity. It is thought that this situation may be caused by the intensity of the curriculum program applied in primary schools and the orientation problems that students experience in the transition from preschool period to academic life. On the other hand, there is no information about whether primary school students receive pre-school education or not. There are many studies showings that preschool education positively affects success in primary school (Camilli et al., 2010). Therefore, it is possible to encounter different analysis findings when preschool education is considered as a covariate factor in primary school comparisons. In other words, the difference in preschool and primary school averages may also be due to preschool education.

Another important finding of the study is that males and females differ in terms of certain cognitive abilities. In this study, it was found that the mean scores of males in preschool were higher than the mean scores of females in VEPI and MCI. In primary school, VEPI scores were in favor of females, whereas MCI scores produced results in favor of males. In secondary school, while SPI scores were in favor of females, BCI scores were higher for males. As can be seen, in gender-based comparisons, there are different advantages for females and males in the areas of verbal potential and memory capacity at different grade levels. However, the fact that females' VEPI scores were higher than males in primary and secondary school periods can be interpreted as females' field-specific skills developed more with educational interventions in crystallized abilities that develop with education.

LIMITATIONS and SUGGESTIONS

In this study, the participants' general intelligence index, visual potential index, verbal potential index and memory capacity index scores are limited to ASIS. On the other hand, the participants of the study are limited to the children of the parents who applied to the EPTS center. Therefore, the sample group consists of students who applied to the center when their parents observed a difference in their children or wanted to determine their intelligence levels. This can be considered as a sample limitation.

Suggestions for further research are as follows:

- The relationship between GIQ, VEPI, VIPI, and CMI scores of students at different levels and their school achievement can be investigated.
- Since the majority of the sample group includes students in Eskişehir province, the sample group can be expanded to include data from different provinces.
- The demographic characteristics of the parents in the study group and the index scores of the students can be compared.
- Gender and grade level comparisons can be made according to whether the students receive preschool education or not.
- Differences between males and females can also be examined in terms of the effect of additional variables such as socioeconomic status, receiving additional supportive training.

ETHICAL TEXT

This article was presented as an oral presentation at the 9th EJER 2022 Conference, which held on 22-25 June 2022.

In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The authors hold the responsibility for any potential violations concerning the content of the article. This research has received ethical approval from the Anadolu University Social and Human Sciences Research and Publication Ethics Committee under protocol number 103155 on 25 December 2019.

Author(s) Contribution Rate: In this research, the first author's contribution rate is 35%, the second author's contribution rate is 35% and the first author's contribution rate is 30%.

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