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A Comparasion of Scientific Literacy Levels of Gifted and Nongifted Students

Özel Yetenekli Olan ve Olmayan Öğrencilerin Bilimsel Okuryazarlık Düzeylerinin Karşılaştırılması

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ABSTRACT: The number of studies related to scientific literacy has increased dramatically. The widespread adoption of information and technology has made such studies necessary on a global scale. In the 21st century, the most crucial area where competition takes place among countries is considered to be information and technology. It is essential to observe the reflections of digital transformation and innovation in using and disseminating knowledge and technology for students and to take steps in educational fields accordingly. In this study, the levels of scientific literacy (SL) of gifted and nongifted students were compared. The participants of the study consisted of 98 gifted students attending the Education Program of Talented Students (EPTS) and 137 nongifted students attending the EPTS' project middle school. The Test of Basic Scientific Literacy (TBSL) was used to determine the students' levels of scientific literacy. The test consists of sub-dimensions of the nature of science (NS) and the science-technology-society relationship (STS). The findings of the research showed that the mean scores of both groups in SL, NS, and STS were at a moderate level. To examine whether there were differences in SL, NS, and STS levels between gifted and nongifted students, independent samples t-tests were conducted. The analysis revealed that gifted students had significantly higher scores in SL, NS, and STS compared to nongifted students ($p<.016$). However, the effect size of the difference was found to be small and medium in theoretical and practical terms.

Keywords: Abilitiy level, scientific literacy, nature of science, science-technology-society relationship

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ÖZ: Bilimsel okuryazarlık kavramına yönelik çalışmaların sayısı son yıllarda artan bir ivme kazanmıştır. Bilgi ve teknoloji kullanımının küresel bir biçimde yaygınlaşması bu türdeki çalışmaları ihtiyaç haline getirmiştir. 21. yüzılda ülkeler arasında rekabetin yaşandığı en önemli alan, bilgi ve teknoloji olarak görülmektedir. Bilginin ve teknolojinin kullanımı ve iletilmesi konusunda yaşanan dijital değişimin ve yeniliğin öğrenciler üzerindeki yansımalarını görmek ve bu doğrultuda eğitimsel adımlar atmak önemlidir. Bu çalışmada özel yetenekli olan öğrenciler ile özel yetenekli olmayan öğrencilerin bilimsel okuryazarlık (BOY) düzeyleri karşılaştırılmıştır. Çalışma grubunu Üstün Yetenekliler Eğitim Programı'na (ÜYEP) devam eden 98 özel yetenekli öğrenci ve ÜYEP proje ortaokuluna devam eden 137 özel yetenekli olmayan öğrenci oluşturmaktadır. Öğrencilerin bilimsel okuryazarlık düzeylerini belirlemek için Temel Bilimsel Okuryazarlık Testi (TBOT) kullanılmıştır. Test, bilimin doğası (BD) ve bilim-teknoloji-toplum ilişkisi (BTT) alt boyutlarından oluşmaktadır. Araştırmada özel yetenekli olan ve olmayan öğrencilerin BOY, BD ve BTT puan ortalamalarının orta düzeyde olduğu bulunmuştur. Özel yetenekli olan ve olmayan öğrencilerin BOY, BD ve BTT düzeylerinin farklılaşıp farklılaşmadığını ortaya koymak amacıyla bağımsız örneklemler t testi gerçekleştirilmiştir. Analiz sonucunda özel yetenekli olan öğrencilerin BOY, BD ve BTT puanlarının özel yetenekli olmayan öğrencilerden anlamlı ($p<.016$) şekilde yüksek olduğu görülmüştür. Ancak farkın etkisinin kuram ve uygulamada küçük ve orta düzeyde olduğu bulunmuştur.

Anahtar sözcükler: Yetenek düzeyi, bilimsel okuryazarlık, bilimin doğası, bilim-teknoloji-toplum ilişkisi

1. INTRODUCTION

With the integration of information and technology usage into many disciplines, 21st-century skills have gained popularity in nearly every field. The Partnership for 21st Century Skills (2008) examines these skills in three categories: learning skills, literacy skills, and life skills. Literacy skills encompass proficiency in areas such as information, media, technology, and science. Scientific literacy, which forms the foundation of these skills, is considered a critical competence to navigate and adapt to technological advancements (Bartan, 2019; Okada, 2013).

The concept of scientific literacy was initially introduced by Hurd (1958) with the aim of emphasizing the importance of science and technology education. According to Hurd, science and technology are among the most distinct features of the modern world. In the evolving world, science and technology play a significant role in the development of countries. Therefore, in the early 21st century, scientific literacy has become an educational slogan and vision (Laugksch, 2000). Mun et al. (2015) also argue that the most essential component of instructional programs is the skill of scientific literacy. Considering that instructional programs are shaped by various socio-cultural learning perspectives, scientific literacy can be regarded as a contextually and temporally evolving concept, socially constructed in nature.

When we consider the experiences gained through scientific, informative, and technological advancements being utilized in every aspect of life, we can assert that scientific literacy is directly related to the ability to make decisions about daily social issues (Suwono, Maulidia, Saefi, Kusairi, & Yuenyong, 2022). Researchers have defined the concept of scientific literacy in various ways. For instance, Arduç and Kahraman (2021) define scientific literacy as the ability to read, comprehend, and interpret a scientific study or topic. Fives, Huebner, Birnbaum, and Nicolich (2014) consider understanding scientific processes and being able to notice scientific information encountered in daily life as scientific literacy. According to Koch and Eckstein (1995), scientific literacy is the ability to interpret, comprehend, and critically analyze a scientific text. Şahin and Ateş (2018) argue that there are two fundamental approaches in defining scientific literacy. The first is the necessity of teaching students' content and process knowledge, while the second is the necessity of instructional programs that enable students to solve everyday problems using scientific methods. Mun et al. (2015), instead of focusing on differences or similarities in definitions, highlight the importance of the skill of scientific literacy and suggest that researchers should delve deeper into the concept.

Scientific literacy encompasses multiple skills (Roth & Barton, 2004). Laugksch and Spargo (1996) indicate the sub-dimensions of scientific literacy as the nature of science (NS), science-technology-society relationships (STS), and scientific content knowledge. However, Turgut (2005) suggests that rather than scientific content knowledge, NS and STS are more crucial in scientific literacy. The researcher believes that integrating these two sub-dimensions into educational programs would contribute more significantly to enhancing students' levels of scientific literacy. NS, which covers epistemological beliefs and the sociology of science, is associated with the use of the scientific research process and scientific products in solving everyday life problems. On the other hand, STS represents the interconnection between science, technology, and society. This study takes into account the skills encompassed by scientific literacy and the two sub-dimensions that constitute it.

In the literature, there have been numerous studies conducted on explaining (Feinstein, 2011; Holbrook & Rannikmae, 2009; Laugksch, 2000; Maienschein, 1998), measuring (Miller, 1998; Romine, Sadler, & Kinslow, 2017; Rundgren, Rundgren, Tseng, Lin, & Chang, 2012; Rusilowati, Kurniawati, Nugroho, & Widiyatmoko, 2016; Şahin & Ateş, 2018; Şahin-Kalyon, 2020), enhancing (Bybee, 1995;

Doğan, Çakıroğlu, Çavuş, Bilican, & Arslan, 2011; Fan & Geelan, 2013; Pongsophon, Yutakom, & BouJaoude, 2010), and the skill of scientific literacy and establishing its relationship with various variables (Benzer, 2020; Kaya, Bahçeci, & Godek Altuk, 2012; Mbajiorgu & Ali, 2003; Tezgören, 2015; Ulutaş, 2009). A compilation of studies in the international literature (Singh & Singh, 2016) emphasizes the necessity and evaluation of scientific literacy skills in science education for societal development. This necessity might be the reason why scientific literacy remains a focus of researchers' agendas. In parallel, the national literature has also addressed the concept of scientific literacy from various perspectives. Arduç and Kahraman (2021) examined 90 research in the national literature conducted until 2019. The majority of these studies were master's theses, focusing on middle and high school students. They also highlighted that most of the studies investigated the relationship between scientific literacy skills and various variables such as grade level, gender, and problem-solving skills.

Researchers have shown that gifted children exhibit different patterns of development compared to their peers in terms of cognitive and socio-emotional attributes (Silverman, 2013). Characteristics such as rapid learning, individual and independent study preferences, extended attention spans, flexibility in problem-solving, effectiveness and adaptability in project-based work, a desire for exploration in areas of interest, advanced self-regulation skills, and the ability to self-motivate are claimed to differentiate based on the identification of giftedness (Çağlar, 2004; Rogers, 2002; Sak, 2014; Webb, Gore, Amend, & DeVries, 2007). In this sense the following question comes to mind: Is there a difference in the level of scientific literacy between gifted and nongifted students? To answer this question, it's necessary to examine research conducted with gifted individuals. For instance, Kömek, Yağız and Kurt (2015) compared the scientific literacy levels of 77 nongifted students and 52 gifted students who were participating in the Science and Art Centers, using Keskin's (2008) scale. The researchers found that gifted students who participated in enrichment education had higher levels of scientific literacy. Additionally, they showed that the average scientific literacy scores were in favor of gifted students. In another study, Nacaroğlu (2020) compared the 21st-century skills of 201 gifted students and 300 nongifted students. The researcher found that gifted students had an advantage in the skills of "Critical Thinking and Problem Solving," "Information and Technology Literacy," "Entrepreneurship and Innovation," and "Social Responsibility and Leadership." Also, the researcher examined the 21st-century skills of gifted and nongifted students separately based on gender and age variables, and the scientific literacy skill was considered as a sub-component. Therefore, it can be said that there is a need for studies that thoroughly examine scientific literacy skills. Furthermore Fausan, Susilo, Gofur, and Yusop (2020) examined the scientific literacy level of 278 gifted students in high school. The research findings show that there was no significant difference in the scientific literacy levels of gifted students based on their grade level. Therefore, the researchers suggested that teachers could use similar activities to develop scientific literacy across different grade levels. In conclusion, while the literature indicates that numerous areas have been studied in the approximately 80-year history of the scientific literacy concept, research on the scientific literacy skills of gifted students is limited. It's important to uncover the scientific literacy levels of these gifted students and compare them with their nongifted peers. Determining whether there is a difference in the scientific literacy levels of these two groups, whether it exists or not, or whether their scores are low or high, could contribute to the evaluation or enhancement of current educational programs. In other words, such research could provide insights into the distribution of educational opportunities and resources among different student groups. Therefore, we can assess that such a study contributes to the literature in terms of educational policies, student development, and technological advancement.

The research demonstrates that the needs of gifted students cannot be met through a standard curriculum (Rogers, 2002). Similarly, understanding the differences in scientific literacy skills could lead to better serving these students through educational policies. This might necessitate the development of special programs and resources to provide appropriate and advanced education for gifted students. On the other hand, it could also offer educational opportunities related to this topic within the core curriculum for nongifted students. Therefore, the development of the 21st-century skill of scientific literacy will enable students to compete in the global world. Examining students' scientific literacy levels can help us understand how to support their development. Recognizing individual differences and supporting students' strengths can help maximize their potential. From a technological development perspective, we can state that scientific literacy forms the foundation for advanced research and innovation in science and technology. The potentials and interests of both gifted and nongifted students in this area can contribute significantly to future scientific discoveries and developments. Therefore, investigating students' scientific literacy levels can encourage progress in science and technology. In conclusion, exploring the differences in scientific literacy levels between gifted and nongifted students allows us to evaluate the opportunities provided by our education system and address achievement inequalities. This research could help us to create a fairer education system and enhance the scientific literacy levels of all students. In this context, the study aims to answer the following research questions:

- What are the gifted and nongifted students' scientific literacy levels, including the sub-dimensions of understanding the nature of science and the relationship between science, technology, and society?
- Do the scientific literacy levels, including the sub-dimensions of understanding the nature of science and the relationship between science, technology, and society, vary between gifted and non-gifted students?

2. METHOD

2.1. Research Design

In this study, the cross-sectional survey model was employed to compare the scientific literacy levels of gifted and non-gifted students. In the survey model, researchers describe characteristics such as interest, perception, attitude, and skills related to a situation or topic using data they have collected themselves or previously collected data (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2011; Creswell, 2014). The cross-sectional survey is a a type of research model in which data are collected at one given point in time across a sample population (Karakaya, 2014). As it is not possible to reach all middle school students who are gifted and nongifted in Eskişehir, the scientific literacy levels of a specific group representing the population will be described and compared.

2.2. Population and Sample

The population of the study consists of gifted and nongifted middle school students in Eskişehir. The sample of the study includes 98 gifted students attending the Education Program of Talented Students (EPTS) and 137 nongifted students attending a regular middle school. The EPTS is a after-school program for gifted students which offers programs for gifted students in middle schools on the weekends during school times and during the summer break. Identification system of the program uses domain-specific assessment of ability such as tests in general ability, science, and mathematics. In addition, the Anadolu Sak Intelligence Scale (ASIS) is applied to students for identification. The regular school has resource rooms for gifted students. The team of the EPTS admnistered the ASIS to identify gifted students. Students with an IQ of 130 and above are admitted to the resourse room. In the scope of the study, the nongifted participants included students who do not participate in the resourse room. Since the current research aims to reach middle school students who were identified as gifted or nongifted with IQ testing in Eskişehir, a purposive sampling method, where researchers choose participants with specific characteristics related to the study topic (Johnson & Christensen, 2014), was used to determine the sample group.

The determination of the sample size was based on the results of a power analysis conducted using GPower 3.1. Power analysis is an analysis that indicates the minimum required sample size for a given analysis in a study (Cohen, 1988). In research where group differences will be calculated, a statistical power of 1- β = 0.95 is considered sufficient (Prajapati, Dunne, & Armstrong, 2010). In this study, a significance level of p = 0.05 was considered. Accordingly, based on the results of the power analysis, it was determined that a sample size of at least 176 students, with a minimum of 88 students in each group, would be sufficient (Figure 1).

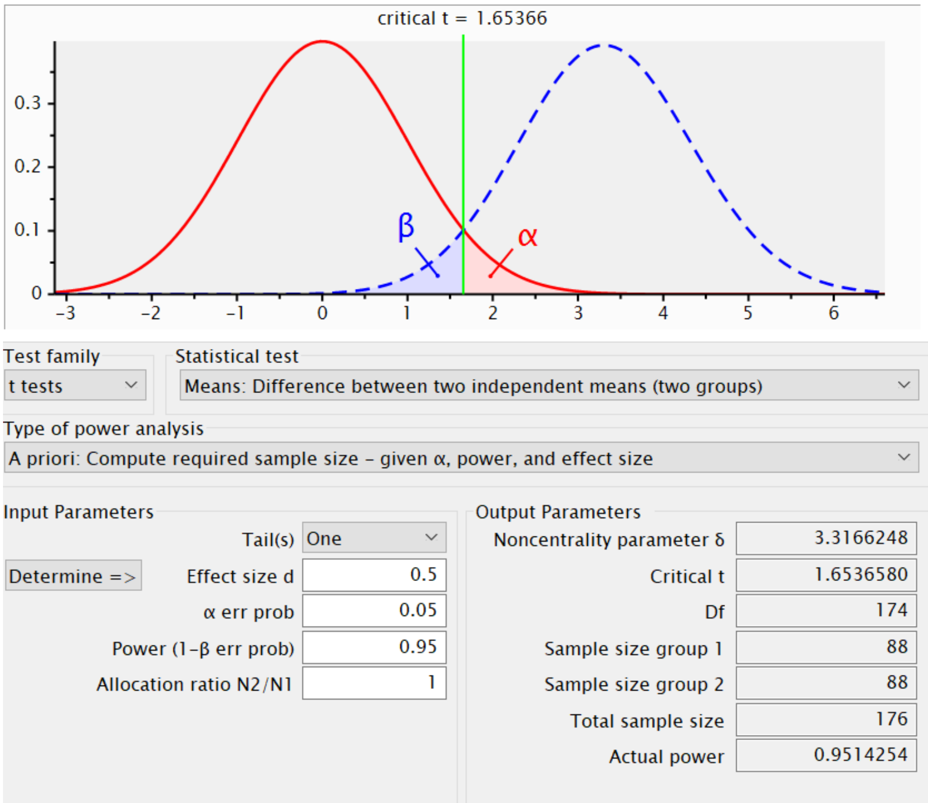

Figure 1: *The Results of the Statistical Power Analysis*

Based on the results of the power analysis, the sample size was determined. Accordingly, the study reached a total of 235 students, including 98 gifted students and 137 non-gifted students. Table 1 represent the demographic information of the sample.

Table 1: *The Demographic Information of the Sample*

	Girl	Boy	Total
Nongifted Students	70	67	137
Gifted Students	25	73	98
Total	95	140	235

2.3. Instrument

The Test of Basic Scientific Literacy (TBSL) was used to determine the scientific literacy (SL) level of the students. The TBSL was developed by Laugksch and Spargo (1996) and adapted from English to Turkish by Turgut (2005). The original scale consisted of 110 items, and the items were evaluated as true, false, or don't know. The scale composed of three sub dimensions namely the nature of science (NS), science-technology-society relations (STS), and scientific content knowledge. However, Turgut (2005) evaluated scientific literacy in the dimensions of science-technology-society relations and the nature of science, so these dimensions of the scale were adapted into Turkish. The TBSL consists of 38 items. Of the total items 16 are in the science-technology-society relationship (STS) subtest and 22 are in the nature of science (NS) subtest. Items are 5-point Likert type. If students receive high scores on any of the sub-dimensions of the TBSL, it means that their understanding levels in that dimension are at an advanced level, which is more scientific (in line with contemporary scientific understanding). On the other hand, if students receive low scores, it means that their understanding levels are naiver (naturally-developed). Since the scoring ranges from 1 to 5, the average value of 3 is considered as the threshold, with scores above 3 being classified as scientific and scores below 3 as naive. The total score was calculated by summing the scores of the two sub-dimensions: STS with 16 items and NS with 22 items. This allowed the calculation of three scores: NS, STS, and overall scientific literacy (SL). In the adaptation process of the scale, it was initially translated into Turkish and then reverse-translated. Subsequently, validity and reliability studies were conducted with a sample of 4227 participants. The construct validity of the scale was established through expert opinions, confirming its two-factor structure. For reliability, Cronbach's alpha values were examined. The researcher reported Cronbach's alpha values of .88 for the nature of science sub-dimension, .92 for science-technology-society relations, and .94 for the entire scale. Additionally, test-retest correlations exceeding .89 indicated the scale's reliability.

In the literature there are various studies in which the TBSL adapted by Turgut (2005) has been used. For instance, in a study investigating the relationship between scientific literacy and media literacy, Benzer (2020) administered the TBSL to 115 teacher candidates and found a Cronbach's alpha coefficient of .78 for the total test reliability. In a study examining the impact of everyday life problems on scientific literacy and various variables, Şencan (2013) applied the TBSL to 66 students in the 7th grade and reported a Cronbach's alpha coefficient of .86 for the total test reliability. In the current study, the TBSL was administered to 235 middle school students, and a Cronbach's alpha coefficient of .81 was found for the total test reliability. As a result, it is considered that the scale is valid, reliable, and easy to administer for use from middle school to undergraduate level.

2.4. Data Collection and Analysis

Data were collected in the EPTS and the EPTS' project middle school for about two weeks. Prior to conducting the data collection process, research approval was obtained from the Ethics Committee of Anadolu University (Protocol No: 440751), and then permission was obtained from the school and program administrators. For the data collection we applied the TBSL to nongifted students who do not attend resourse room for gifted students and gifted students who attended the EPTS.

In the scope of data analysis, missing values were first examined. It was observed that the missing values resulting from incomplete responses to the TBSL scale by the study group were randomly distributed in the dataset (Little's MCAR Test: $p > .05$). To eliminate the randomly patterned missing data, item means were calculated and assigned to the variables containing missing data (Mertler & Vannatta, 2005). Secondly, descriptive statistics were examined. Thirdly, the assumptions of the t-test for independent samples were tested within the research question. In the conducted normality assumption analyses, it was observed that the kurtosis and skewness values were within the ±2 limits (Trochim & Donnelly, 2006). Furthermore, through the Levene test, it was observed that in the intergroup comparisons made for the dependent variables BD, BTT, and BOY, the population variances were homogenous ($p > .05$). After preliminary assumptions were determined, independent samples t-tests were conducted.

3. FINDINGS

3.1. Descriptive Findings

Descriptive statistics regarding the scientific literacy levels obtained from the TBSL for the participants are presented in Table 2.

Table 2: *Descriptive Findings*

N=235	Minimum	Maximum	$\bar{X}$	sd
NS	2.27	3.91	3.22	0.27
STS	2.5	4.19	3.42	0.31
SL	2.45	3.92	3.31	0.24

** NS: Nature of science, STS: Science-technology-society relations, SL: Scientific literacy*

When we examine Table 2, it can be observed that the lowest score obtained from the TBSL is 2.27 and the highest score is 4.19. On the other hand, the mean scores obtained from the TBSL range from 3.22 to 3.42. Based on this, it can be stated that the study group's scientific literacy levels are not significantly different from the mean. Table 3 provides a distribution of gifted and non-gifted students' levels of NS, STS and SL.

We found that 82.65% of gifted students were within scientific boundaries in terms of their understanding of the nature of science. 96.94% of them were within scientific boundaries in terms of both science-technology-society relationships and scientific literacy. Therefore, it is observed that a large majority of gifted students have high levels of scientific literacy. On the other hand, 78.10% of nongifted students are within scientific boundaries in terms of the nature of science, 83.21% in terms of science-technology-society relationships, and 88.32% in terms of scientific literacy (see Table 3).

Table 3: *Frequencies for the Level of NS, STS and SL*

			f	%
NS	Nongifted students	Naive (Average < 3)	25	18.25
		Average (3)	5	3.65
		Scientific (Average > 3)	107	78.10
	Gifted students	Naive (Average < 3)	12	12.24
		Average (3)	5	5.10
		Scientific (Average > 3)	81	82.65
STS	Nongifted students	Naive (Average < 3)	14	10.22
		Average (3)	9	6.57
		Scientific (Average > 3)	114	83.21
	Gifted students	Naive (Average < 3)	2	2.04
		Average (3)	1	1.02
		Scientific (Average > 3)	95	96.94
SL	Nongifted students	Naive (Average < 3)	12	8.76
		Average (3)	4	2.92
		Scientific (Average > 3)	121	88.32
	Gifted students	Naive (Average < 3)	2	2.04
		Average (3)	1	1.02
		Scientific (Average > 3)	95	96.94

** NS: Nature of science, STS: Science-technology-society relations, SL: Scientific literacy*

3.2. Comparison of Scientific Literacy According to Talent Levels

To compare gifted and nongifted students in terms of NS, STS, and SL, independent samples t-test was conducted within the research. The analysis results are presented in Table 4.

Table 4: *Independent Samples t-test Results According to Talent Levels*

	Talent Levels	N	$\overline{X}$	sd	t	df	p<	η^2
NS	Nongifted Students	137	3.1839	0.26305	-2.677	233	.008	.030
	Gifted Students	98	3.2779	0.2682				
STS	Nongifted Students	137	3.3292	0.29252	-5.536	233	.000	.116
	Gifted Students	98	3.5452	0.29825				
SL	Nongifted Students	137	3.2446	0.22789	-4.719	233	.000	.087
	Gifted Students	98	3.3892	0.23664				

** NS: Nature of science, STS: Science-technology-society relations, SL: Scientific literacy*

As seen in Table 4, gifted and nongifted students' average scores for NS, STS and SL were varied. In order to determine whether the levels of NS, STS and SL of participants changed by being gifted or nongifted independent samples t-test analyses were conducted three times for each dependent variable. However, to avoid Type 1 error because of the risk of making multiple comparisons with the same group in the same dataset (NS, STS and SL), a Bonferroni correction was applied (Huck, 2012). Consequently, the significance level for t-test comparisons was set at .016 (.05/3 comparisons).

Independent samples t-tests revealed that gifted students had significantly higher scores in NS understanding ($t(233) = -2.677$, $p < .016$). The NS understanding levels of gifted students ($\bar{X} = 3.28$) are higher compared to non-gifted students ($\bar{X} = 3.18$). Furthermore, we examined the value of eta squared ($\eta^2 = .030$), and found that the effect size was small (Huck, 2012). In other words, it was found that the statistical difference between the groups had a small impact in theory and practice.

Independent samples t-tests revealed that gifted students had significantly higher scores in BTT understanding ($t(233)= -5.536$, $p<.016$). The STS understanding levels of gifted students ($\bar{X} = 3.55$) are higher compared to non-gifted students ($\bar{X} = 3.33$). Furthermore, we examined the value of eta squared ($\eta^2 = .116$), and found that the effect size was moderate (Huck, 2012). In other words, it was found that the statistical difference between the groups had a moderate impact in theory and practice.

Independent samples t-tests revealed that gifted students had significantly higher scores in SL understanding ($t(233)= -5.536$, $p<.016$). The SL understanding levels of gifted students ($\bar{X} = 3.39$) are higher compared to non-gifted students ($\bar{X} = 3.25$). Furthermore, we examined the value of eta squared ($\eta^2 = .087$), and found that the effect size was moderate (Huck, 2012). In other words, it was found that the statistical difference between the groups had a moderate impact in theory and practice.

4. DISCUSSION and RESULT

In the research, we found that the middle school students' understanding of scientific literacy (SL) were 3.31 (sd = .24). Thus, since the average is above 3, it can be inferred that the middle school students' understanding of SL is scientific (in line with a contemporary understanding of science). On the other hand, for the nature of science (NS) sub-dimension, the mean was 3.22 (sd = .27), while it was 3.42 (sd = .31) for the science-technology-society relationship (STS) sub-dimension. When looking at the sub-dimension averages, it can be observed that middle school students' understanding levels of NS and STS are within scientific boundaries. However, since students' averages for NS, STS, and SL are close to 3, it can be stated that they are close to the lower limit of scientific understanding. Şencan (2013) conducted an experimental study with 66 students at the 7th-grade level, administering the TBSL as a pre-test and post-test. The average scores for NS ($\bar{X} = 1.84$), STS ($\bar{X} = 1.36$), and SL ($\bar{X} = 1.63$) before any intervention program was applied in the experimental and control groups were found to be considerably below 3. Özdem, Çavaş, Çavaş, Çakıroğlu, and Ertepınar (2010) applied the TBSL developed by Laugksch and Spargo (1996) to 946 students in grades 6, 7, and 8. The researchers reported that middle school students' levels of scientific literacy were below the average. In two different studies evaluating students' scientific literacy levels using different scales (Kütükçü, 2016; Şahin & Ateş, 2018), it was also found that students' scientific literacy levels were below the average. The Programme for International Student Assessment (PISA), a significant international assessment of scientific literacy funded by the Organization for Economic Cooperation and Development (OECD) also indicates that Turkey's results for scientific literacy are below the average (Bybee, 2008). When examining PISA results from 2003 to 2018, it is not possible to speak of a consistently increasing or decreasing average curve when comparing the other countries' overall averages with Turkey's average. However, considering all years, Turkey's performance in all PISA tests is consistently below the OECD countries' average (MEB, 2019). On the other hand, two different studies (Keskin, Tezel & Acat, 2016; Tezel & Tezgören, 2019) found that middle school students' scientific literacy levels were at a moderate level.

When considering the findings of this study along with the empirical research from different years in the literature, it becomes evident that the scientific literacy levels of middle school students are either average or below average. However, for a society in the technology era like the 21st century, it is crucial to have a high level of scientific literacy. This is because a country's economic and educational development in the last century has predominantly been achieved through the correct interpretation of science and its adaptation to relevant conditions. Enhancing the scientific literacy levels within cultures is directly connected to education, and at this point, policymakers in the field of education play a significant role.

In Turkey, various initiatives related to scientific literacy have been undertaken in the Science Curriculum since 2013. The 2017 and 2018 programs integrated scientific literacy with the content of disciplinary fields like mathematics and science. For example, the 2018 program merged science, mathematics, technology, and engineering fields and included activities like designing products and science fairs (Başar & Demiral, 2019). Despite these efforts to enhance scientific literacy in the content of the programs, there are certain limitations. For instance, when looking at the middle school curriculum of the Ministry of National Education (MEB, 2018), there is only one elective course in this scope. Within the Science Applications course, there are 10 learning areas defined for scientific literacy enhancement, including "Acquiring Scientific Knowledge, Scientific Methods, Variability of Scientific Knowledge, Imagination and Creativity in Science, Types of Scientific Knowledge, Subjectivity of Scientific Knowledge, Relationship of Science with Other Disciplines, Scientific Ethics, Product Creation, and Entrepreneurship". The content of each learning area is seen to contribute to scientific literacy. However, the elective nature of this course limits its visibility and accessibility to wider audiences. Making this course mandatory could be an important step towards fostering individuals who can produce, functionally use, and interpret scientific knowledge.

As a result, it is evident that middle school students in Turkey, including gifted students, do not possess a high level of scientific literacy understanding. Therefore, it is recommended to add content related to understanding the nature of science in the Science Curriculum, and more activities should be included to develop students' research skills (data collection, data interpretation, etc.) and higher-order thinking skills (analytical thinking, creative thinking, critical thinking, etc.). In these programs, technological tools could be made functional through internet research, simulations, and the use of science-based applications, all of which aim to enhance the science-society-technology relationship. Additionally, there is a need to include more activities that involve participating in scientific activities and integrating science into daily life (Lindner & Kubat, 2014). For the development of both sub-dimensions, factors that have an impact on enhancing scientific literacy, such as evaluation, the quality of textbooks used, teacher training, and collaboration with families (BouJaoude, 2002), should be taken into consideration.

In this study, when comparing the NS ($\overline{X}_{gifted}$=3.28, $\overline{X}_{nongifted}$=3.18), STS ($\overline{X}_{gifted}$=3.55, $\overline{X}_{nongifted}$=3.33) and SL ($\overline{X}_{gifted}$=3.39, $\overline{X}_{nongifted}$=3.25) score averages of gifted and nongifted students, a statistically significant difference in favor of gifted students was found ($p < .016$). However, the impact of this difference in theory and practice was small to moderate. Considering the effect size value, it was observed that although the difference between the averages of gifted and nongifted students was statistically significant, it was not very substantial. In other words, it can be stated that gifted and nongifted students have almost similar levels of scientific literacy understanding. In studies conducted in the literature with gifted and nongifted students, it is observed that the scientific literacy averages of gifted students are significantly higher compared to non-gifted students (Al-Hammadi & Taher, 2013; Kömek et al., 2015; Nacaroğlu, 2020). However, when examining the score averages of study groups representing two different groups in these studies, parallel to this research, it is observed that both groups' scores are in favor of the gifted group, but the difference in averages is not substantial. Considering the content of the primary education program of the Ministry of National Education (MEB), there is no mandatory course specifically for developing scientific literacy; rather, there is an elective course. On the other hand, post-school education programs designed for individuals diagnosed with giftedness (such as the EPTS, Science and Art Centers, etc.) also lack a course specifically aimed at enhancing scientific literacy. The limitation of these courses and practices to create skills and awareness in students could be a reason for the similarity in the average scores of both groups for both SL and its sub-dimensions, NS and STS. Taking the entirety of the research into consideration, it can be said that there is a need for practices that aim at developing scientific literacy skills in both formal education institutions and differentiated programs for gifted students.

In conclusion, the research findings indicate that the averages of values obtained for SL, NS, and STS are at a moderate level for both gifted and non-gifted students. While the scores of gifted students for SL, NS, and STS are higher than those of non-gifted students, the effect of this difference is observed to be small to moderate in both theory and practice.

4.1. Limitations

This research is limited to the sample from Eskişehir. Within the scope of the study, the diagnosis of giftedness is limited to the EPTS identification system. Furthermore, scientific literacy is limited to the scope of skills measured by TBSL.

4.2. Suggestions

In this research, which evaluates students' scientific literacy levels according to their aptitude levels, it is observed that the averages of values obtained for SL, NS, and STS are three or above (indicating a scientific level). Additionally, a difference in favor of gifted students is noted, but the impact of this difference is considered small to moderate in both theory and practice. When considering the findings of other research in the literature, PISA results, and the findings of this study, it becomes evident that both gifted students and middle school students as a whole require support in terms of scientific literacy. Thus, at a macro level, emphasizing scientific literacy in national education policies can be an important step. At a micro level, adding mandatory courses that focus on developing scientific literacy skills to the curriculum in both formal education institutions under the Ministry of National Education (MEB) and extracurricular programs for gifted individuals, integrating the concept of scientific literacy into teacher training programs, and organizing camps dedicated to the development of scientific literacy, similar to practices abroad, can be recommended. Furthermore, considering that scientific literacy encompasses subjects like technology, engineering, architecture, natural sciences, mathematics, etc., activities related to scientific literacy can be incorporated into the content of these subjects within the MEB curriculum to create awareness among students. This research focused on middle school students. Conducting both quantitative and qualitative studies with students at different grade levels could yield comprehensive results and recommendations regarding the level of scientific literacy and needs in the Turkish context.

Author Contributions

The authors contributed equally to the research.

Conflict of Interest

The authors declared that they have no conflict of interest.

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