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Analysis of Scientific Epistemological Beliefs and STEM Attitudes of the Gifted Students

İsmail Dönmez*[a], Semra Yalmancı-Yücel[b]

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Abstract

The aim of this study is to analyze STEM (science, technology, engineering, mathematics) attitudes, epistemological beliefs and the relationship between STEM attitudes, epistemological beliefs of gifted students. For this purpose, the attitude and level of epistemological belief in STEM fields; It was analysed whether the dimensions of STEM, 21st century skills and epistemological beliefs that make up the STEM attitude dimensions differ in authority and accuracy, the process of producing knowledge, the source of knowledge, reasoning, and variability of knowledge. The sample of the study consists of totally 105 gifted students who have attended in two different science and art centres. In the study, descriptive survey model used which is one of the quantitative researches. Non-parametric tests have been used for the analysis of the data obtained. As a result of the study, it has been observed that students with superior intelligence have a scientific epistemological belief at an advanced (contemporary) level of information generation, reasoning and variance of information, while they have a traditional epistemological belief in the sub-dimensions of authority-accuracy and source of information, As for the STEM attitudes, it has been found out that they have low averages in the dimensions of math and science.

Üstün Zekâlı Öğrencilerin Bilimsel Epistemolojik İnançları ile STEM Tutumlarının İncelenmesi

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Öz

Bu çalışmanın amacı üstün zekalı öğrencilerin STEM tutum, epistemolojik inanç ve STEM tutum epistemolojik inançlarının arasındaki ilişkiyi incelemektir. Bu amaç doğrultusunda STEM (bilim, teknoloji, mühendislik, matematik) alanlarına yönelik tutum ve epistemolojik inanç düzeyi; STEM tutum boyutlarını oluşturan, fen, matematik, mühendislik-teknoloji, 21.yy becerileri ve epistemolojik inanç boyutların otorite ve doğruluk, bilgi üretme süreci, bilginin kaynağı, akıl yürütme, bilginin değişirliği boyutlarında farklılaşıp farklılaşmadığı incelenmiştir. Araştırmanın örneklemini iki bilim ve sanat merkezine (BILSEM) devam etmekte olan toplam 105 üstün zekalı öğrenci oluşturmuştur. Nicel araştırma yöntemlerimden betimsel tarama modelinin kullanıldığı bu araştırmada verilerin çözümlenmesi için parametrik olmayan testler kullanılmıştır. Araştırma sonucunda üstün zekâlı öğrencilerin; otorite ve doğruluk ve bilginin kaynağı alt boyutunda geleneksel, bilgi üretme süreci, akıl yürütme, bilginin değişirliği gelişmiş (çağdaş) düzeyde bilimsel epistemolojik inanca sahip oldukları görülmektedir. STEM tutumlarından matematik ve fen boyutlarında düşük ortalamalar sahip olduğu görülmüştür.

***Corresponding Author:** i.donmez@alparslan.edu.tr
[a] Dr., Muş Alparslan University, Muş/Turkey, http://orcid.org/0000-0002-7792-0169
[b] Teacher., Kdz. Ereğli Science and Art Center (BILSEM), Zonguldak/Turkey, http://orcid.org/0000-0002-6070-7935

Introduction

Epistemological beliefs or beliefs are considered as individuals' perspectives on what the information is, how it is collected and what the limits and criteria of that information are (Perry, 1981). These beliefs have a deterministic effect on the variables such as the way individuals process and interpret the information they encounter, their strategies for studying, their high-level thinking and problem-solving approaches, and the effort and time they spend for learning (Tolhurst, 2007). Scientific epistemological beliefs of the students affect the way they understand how scientific information is formed and evaluated, and how they can learn science; in other words, their understanding of the nature of science (Elder, 1999). Attitude is defined as the tendency to react positively or negatively to an object, person or event (Fishbein & Ajzen, 1975). Oppenheim (1992) defines attitude in a single sentence as a belief, a choice, a decision, an emotional feeling and the position taken against anything. When considered as the process of perception, interpretation and internalization of the information; it is impossible for epistemological beliefs not to affect an individual's attitudes and behaviours. This situation reveals the importance of the development of epistemological belief that an individual has in developing positive attitudes and behaviours (Demir & Akınoğlu, 2010). Epistemological beliefs are subjective belief systems related to the accuracy of information, the source of information, the formation of information by the individual, the learning of information and the structure of information. Attitude, on the other hand, plays an important role in the process of learning due to its effect on the formation of students' decisions and behaviours. Attitudes and beliefs are in close connection with each other in terms of the cause and effect relationship (Çöllü & Öztürk, 2006). Attitudes are hidden within certain value judgments and beliefs, and they exist as long as the beliefs and value judgments on which they are based maintain continuity. When the literature on science and mathematics is examined, it becomes clear that there are significant studies that measure the students' attitudes towards science and mathematics. However, very few studies have investigated the epistemological beliefs of middle school students (Akgün & Gülmez, 2015; Aydemir et al., 2013; Önen, 2011). In the study that Önen (2011) conducted, the epistemological beliefs of high school students and their attitudes towards studying have been analyzed. As a result of the study, it has been stated that there is a significant correlation between the epistemological beliefs and the attitudes towards studying. However, when the scientific epistemological beliefs of high school students have been examined according to their genders, it has been stated that female students have more developed epistemological beliefs than male students. According to the grade level variable, it has been concluded that the beliefs develop as the grade level increases. Aydemir et al. (2013) have examined how high school students' epistemological beliefs change according to the grade level and gender variable. It has been concluded that the grade level has a significant effect on the sub-dimensions; the source, invariance and development of information. On the other hand, it is stated that the gender variable has a significant effect on the students' beliefs in the justification of information, which is in favour of female students. In their study aimed at analyzing the effect of high school students' epistemological beliefs on their academic success in chemistry courses, Akgün and Gülmez (2015) have found out that female students have more developed beliefs than male students. Aşut and Köksal (2015) have dealt with the correlation between the gifted students' epistemological beliefs and the level of their motivation and success in learning science, and they have pointed out that gifted students show a medium level of development in terms of scientific epistemological beliefs. In the study which they conducted on gifted high school students, Schommer and Dunnell (1997) have found out that the students have a medium level of development in epistemological belief within the dimensions of the source of information, the speed of learning, the ability to learn and the invariance of information. As can be seen, the relationship between epistemological beliefs and learning, comprehension and academic performance in recent years has been involved in many studies. No study examining the extent of the relationship between STEM (science, technology, engineering, mathematic) education and their scientific epistemological beliefs is encountered for gifted students.

STEM is an interdisciplinary approach that links academic content with real-world situations in science (Akgündüz et al., 2015) technology, engineering, and mathematics, incorporating this content into school, community, business and global initiatives (Lacey & Wright, 2009), and the development of new economic competition conditions through STEM literacy (Balka, 2011; Zollman, 2012). Integrated STEM activities aims for students to pursue careers in STEM fields. On the other hand, it is possible to measure STEM attitudes of students by measuring each discipline individually instead of measuring them in an integrated way. Therefore, the formation of information by the students, learning the information and understanding how subjective belief systems related to the structure of information are shaped will facilitate the understanding of their decisions and

behaviours towards STEM fields. The researchers defending the integrated approach also in STEM education argue that students' interest, motivation and success can be improved through the topics involving problems encountered in current life, and this situation will lead to an increase in the number of students who want to make their career plan in STEM fields (Gülhan & Şahin, 2016). Gifted students favour authentic learning in STEM subjects that bring meaning to the content, either personally or contextually (Morris et al., 2019). Gifted learners are responsive to a degree of autonomy over their own learning, including learning in STEM subjects (Mullet et al. 2018). Students' attitudes towards STEM, which is the most important change movement in the education field of the 21st century, are highly important. Analysing attitudes towards STEM will contribute to determining the STEM career potentials that countries will need in the future and making necessary arrangements to increase the STEM career interest. (Kennedy et al., 2016). The gifted students' beliefs in science will affect their attitudes towards STEM fields and will indirectly contribute to making career in these fields, which is one of STEM's greatest goals (Leslie et al., 2015; Smith et al., 2013). According to King and Magun-Jackson (2009), there are many attempts to increase student participation in science, technology, engineering and mathematics (STEM). It is necessary to examine the nature, histories, and epistemologies of each STEM discipline to consider the promises and perils that lay ahead for an integration effort that assumes a commonality across these fields does exist (Reynante et al. 2020). There is a growing interest to determine factors in towards STEM education. Science and technology education should be prepared in an inclusive manner for all members of the society. In this context, STEM attitudes and epistemological beliefs should be determined in order to increase the quality of science education to be provided to gifted individuals and society. It can be further explored by focusing on issues related to the epistemological nature and validity of information that tends to be addressed. The main purpose of this study is to analyze STEM attitudes, epistemological beliefs and the relationship between STEM attitudes, epistemological beliefs of gifted students. Within the framework of this purpose, some answers are also sought for the following sub-questions:

- What are the epistemological belief information levels of gifted students?
- Do epistemological beliefs of gifted students show significant differences by gender?
- What are STEM attitudes of gifted students?
- Do STEM attitudes of gifted students differ significantly by gender?
- Is there a correlation between the epistemological beliefs of gifted students and their STEM attitudes?

Method

It was used descriptive survey method, which is one of the quantitative researches. In this study, the descriptive survey model has been utilized for the purpose of analyzing the aim, scope and methodology of the researches made in the field of epistemological beliefs and STEM attitudes of gifted students. The reason why survey model has been used in this study is that these models are suitable for the researches which are aimed at describing a past or present situation as what it is (Karasar, 1999).

Population and Sample

The population of the study consists of gifted students who receiving education in two Science and Art Centers (BİLSEM) in Ankara and Zonguldak in the 2018-2019 academic year. BILSEM is an independent private education institution that has been opened in order to ensure that specially gifted students (painting, music and general mental ability) in primary, secondary and high school age are aware of their individual abilities in their formal education and to develop their capacity and use them at the highest level (Ministry of Education [MoNE], 2017a). Children, who are considered to be gifted in terms of painting, music and mental ability, are subjected to exams held by BİLSEM in two stages. Children who achieve the desired success in the exams are admitted to BİLSEM programs in Turkey. The sample of the study consists of 105 gifted students receiving education at BILSEM. The study consists of 42.9% female (f = 45) and 57.1% male (f = 60) gifted students. Cluster sampling was preferred in determining the sample of the study (Büyüköztürk et al., 2014). The epistemological belief scale and STEM attitudes scale were applied to the students in the classroom by researchers. After the instructions given by the researchers, the students answered the test individually. The implementation of the scales took 15-20 minutes.

Data Collection Tools

In this section, the characteristics of scientific epistemological belief scale and STEM attitude scale, which are the data collection tools used in the research, have been included.

Scientific Epistemological Beliefs Scale

In this study, "Scientific Epistemological Beliefs Scale", which was developed by Elder (1999) and adapted to Turkish by Acat et al. (2010), has been used for the purpose of determining the scientific epistemological beliefs of the students. This scale has been developed in accordance with the Likert-type five-point grading system and the levels “Totally Agree”, "Agree", “Undecided”, "Disagree” and “Totally Disagree” have been used for each item. There are 25 items in the scale. Scale consists five dimensions *Authority and Accuracy* (AA) (1., 5., 12., 15., 16., 20., 23., 24., 25. items), *Information Generation Process* (IGP) (3., 4., 7., 8., 11., 18. items), *Source of Information* (SI) (6., 10., 13., 14. items), *Reasoning (R)*(2., 21., 22. items) *Variance of Information* (VI) (9., 17., 19. items). 15 of the items contain negative judgments and 10 of them contain positive judgments. The lowest score that can be obtained from the scale is 25 and the highest score is 125. In the analysis performed by the researcher regarding the scale, it has been pointed out that the scale consists of five factors explaining the total variance ratio of 53.34%. The factors in question are authority and accuracy, information generation process, source of information, reasoning and variance of information. As a result of the reliability analysis of the scale, Cronbach Alpha reliability coefficients have been determined to be between 0.86 and 0.57 for the above-mentioned subscales. Cronbach's alpha reliability coefficient for the whole scale has been determined as 0.82 (Acat et al., 2010). For this study, the reliability of the scale has been re-calculated. Cronbach Alpha reliability coefficient has been found to be 0.87 for authority and accuracy while it is 0,86 for information generation process; 0.71 for source of information; 0.85 for reasoning and 0.74 for variance of information. In addition, Cronbach's alpha reliability coefficient for the whole scale has been found to be 0.83.

STEM Attitude Scale

STEM attitude scale has been developed by the Friday Institute for Innovative Practices in Education (2012) in order to determine the attitudes towards the fields of science, technology, engineering and mathematics. The scale consists 5 dimensions Mathematics (MT), Science (SC), Engineering and Technology (ET), 21st Century Skills (CS), of 37 items and has been developed in a 5-point Likert type. The items in the scale have been graded between “Strongly Agree (5)” and “Strongly Disagree (1)”. The scale has a structure with a maximum score of 185 and a minimum of 37 points. The scale has been adapted to Turkish by Özcan and Koca (2019). The Cronbach Alpha internal consistency coefficient in the scale is 0.86 for mathematics, 0.87 for science, 0.86 for both engineering and technology, and 0.88 for 21st century skills. The Cronbach Alpha reliability coefficient calculated for the whole scale has been found to be 0.91. The Cronbach Alpha internal consistency coefficient calculated in this study is above 0.70, which indicates that the scale is reliable (Büyüköztürk et al., 2015; Nunnally & Bernstein, 1994). The scale developed consists of 8 items in mathematics dimension, 9 items in science dimension, 9 items in engineering and technology dimension and 11 items in 21st century skills dimension.

Data Analysis

Kolmogorov-Smirnov and Shapiro-Wilk tests (Table 1) have been used to determine whether the scientific epistemological belief scores and STEM attitudes have a normal distribution. It has been observed that the scores obtained do not meet the assumption of normality ($p < .05$). In the cases where the dependent variable scores do not meet the assumption of normality in each sub-dimension of the independent variable, Mann Whitney U-test has been used for two unrelated samples and Kruskal Wallis H-test is used for unrelated k-sample (Büyüköztürk et al., 2015). Within the scope of this research, the participant students with the scientific epistemological belief scale’s score of 1.0-2.5 have been determined to be traditional; the ones with 2.5-3.5 to be mixed (medium level); and the ones with 3.5-5.0 to be constructivist. In addition; students' traditional beliefs are expressed as undeveloped (traditional) and their constructivist beliefs are also expressed as advanced (contemporary). Although 15 items in the scale contain negative judgment, 2 of them (items 3 and 7) are reverse coded. The reason for this is that the other 13 negative judgments are included in the negative sub-dimensions.

Table 1. Normality Test for Measurement Tools

Measurement Tools	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Epistemological Beliefs	.188	105	.000	.815	105	.000
STEM Attitude	.132	105	.000	.884	105	.000

Findings

In this section, findings are presented in the scope of research sub-problems.

The findings related to the first sub-problem: "What is the epistemological belief information level of gifted students?"

When table 2 is examined, it is seen that the average score of the students is 2.28 for authority and accuracy sub-dimension and it is 2.87 for source of information sub-dimension. When the students' average scores obtained from these sub-dimensions containing negative items are taken into consideration, it can be said that their beliefs in these dimensions are at a traditional level. In addition, it is seen that students have scientific epistemological belief at advanced (contemporary) level with the average scores of 4.30 in information generation process sub-dimension, 4.41 in reasoning sub-dimension and 4.33 in variance of information sub-dimension.

Table 2. Epistemological Belief Information Levels of Gifted Students

Dimension	N	X	SD
Authority and Accuracy	105	2.28	0.82
Information Generation Process	105	3.64	0.29
Source of Information	105	2.87	0.83
Reasoning	105	4.41	0.58
Variance of Information	105	4.33	0.44

The findings related to the second sub-problem: Does the epistemological beliefs of gifted students show significant differences by gender?"

Mann Whitney U test was used to examine epistemological beliefs according to gender factor in table 3. The Mann Whitney U [MWU] test is used to test the zero hypothesis that "two independent samples come from the same masses" without having to assume that the masses from which the sample was drawn fit normal distributions. When the sub-dimensions were examined in epistemological beliefs, it was observed that there was a relationship between some sub-dimensions (AA-SI, AA-VI, IGP-SI, IGP-VI, AA-R). For this reason, bonferroni correction was made to check for type I error. Bonferroni correction is determined by the formula of p / k, meaningfulness level / number of groups (Higginbotham, 1996; Miller, 1991; Yüksel, 2004). The number of groups was calculated as five dimensions. The significance level was determined as 0.05 / 5 = 0.01 It was determined that the average scores of the female and male students in terms of authority and accuracy show a statistically significant difference, which is in favour of female students (U_{AA}= 792.000; p<0.01). In addition, it has been determined that the average scores of female and male students in information generation process, source of information, reasoning, variance of information sub-dimension do not show a statistically significant difference according to gender (U_{IGP}=1017.000, $U_{SI} = 981.000, U_R = 1003.500, U_{VI}$= 1075.500; p> 0.01).

Table 3. Analysis of Epistemological Beliefs of Gifted Students According to Gender Variable

Dimensions	Gender	N	Mean Rank	Total Rank	U	*p*
Authority and Accuracy	female	45	65.40	2943.00	792.000	.000*
	male	60	43.70	2622.00		
Information Generation Process	female	45	60.40	2718.00	1017.000	.027
	male	60	47.45	2847.00		
Source of Information	female	45	61.20	2754.00	981.000	.016
	male	60	46.85	2811.00		
Reasoning	female	45	45.30	2038.50	1003.500	.021
	male	60	58.78	3526.50		
Variance of Information	female	45	59.10	2659.50	1075.500	.067
	male	60	48.43	2905.50		

The findings related to the third sub-problem: "What are STEM attitudes of gifted students?"

Table 4 shows the STEM attitude levels of gifted students. It is seen that the average score in mathematics dimension is 3.81. It is seen that the average scores are 3.96 in science dimension, 4.27 in engineering-technology dimension and 4.46 in 21st century skills dimension. It is seen that the highest average is in the 21st century skills dimension and the lowest average is in mathematics dimension.

Table 4. STEM Attitudes of Gifted Students

STEM Dimensions	N	X	SD
Mathematics	105	3.81	0.65
Science	105	3.96	0.61
Engineering and Technology	105	4.27	0.67
21st Century Skills	105	4.46	0.53

The findings related to the fourth sub-problem: Do STEM Attitudes of gifted students show significant differences by gender?"

Mann Whitney U test was used to examine STEM attitudes according to gender factor in table 5. When the sub-dimensions were examined in epistemological beliefs, it was observed that there was a relationship between some sub-dimensions. Bonferroni correction was made to check for type I error. Bonferroni correction is determined by the formula of p / k, meaningfulness level / number of groups (Higginbotham, 1996; Miller, 1991; Yüksel, 2004). The number of groups was calculated as four sub-dimentions. The significance level was determined as 0.05 / 4 = 0.0125. When Table 5 is examined, it is seen that the average scores of male and female students in mathematics, science, engineering and technology sub-dimensions show a statistically significant difference, which is in favour of male students (U_{MT}= =526.500, U_{SC}= 931.500, U_{ET}= 720.000; p <0.0125). However, it is seen that there is no significant difference in 21st century skills (U_{CS}= 1038.000; p >0.0125).

Table 5. Analysis of STEM Attitudes of Gifted Students According to Gender Variable

Dimension	Gender	N	Mean Rank	Total Rank	U	*p*
Mathematics	female	45	34.70	1561.50	526.500	0.000*
	male	60	66.73	4003.50		
Science	female	45	43.70	1966.50	931.500	0.006*
	male	60	59.98	3598.50		
Engineering and Technology	female	45	39.00	1755.00	720.000	0.000*
	male	60	63.50	3810.00		
21st Century Skills	female	45	46.07	2073.00	1038.000	0.041
	male	60	58.20	3492.00		

The findings related to the fifth sub-problem: Is there a correlation between the epistemological beliefs of gifted students and STEM attitudes?"

Table 6 shows that there is a low correlation between epistemological beliefs and STEM attitudes ($p < 0.05$). Spearman moments multiplication correlation analysis has been applied. The significant correlation coefficients have been evaluated to be very weak with 0.00-0.25, weak with 0.26-0.49, medium with 0.50-0.69, high with 0.70-0.89 and very high with 0.90-1.00 (Kalaycı, 2010).

Table 6. Correlation Between Epistemological Beliefs and STEM Attitude

Variable	Correlation	*p*
Epistemological Belief * STEM Attitude	0.216*	0.049

It has been examined by using spearman correlation coefficient whether there is a correlation between epistemological belief dimensions and STEM attitudes of gifted students in table 7. in the dimensions of authority and accuracy, information generation process and source of information, p value has been observed to be greater than 0.05. in reasoning dimension, there is a strong correlation with STEM attitude ($r = 0.319$; $p = 0.01$). There is a medium-level positive correlation between epistemological beliefs and STEM attitudes.

Table 7. Correlation Between Epistemological Belief Dimensions and STEM Attitude

Variable	N	r	*p*
Authority and Accuracy	105	0.103	0.296
Information Generation Process	105	0.074	0.450
Source of Information	105	0.134	0.174
Reasoning	105	0.319	0.01*
Variance of Information	105	0.155	0.114

It has been examined by using spearman correlation coefficient whether there is a correlation between STEM attitude dimensions and epistemological beliefs of gifted students in table 8. It is seen that p value is greater than 0.05 in science, engineering and technology and 21st century skills dimensions. Therefore, there is no relationship between STEM attitude dimensions and epistemological beliefs in these areas. In mathematics dimension, there is a weak positive correlation with epistemological belief ($r = 0.300$; $p = 0.01$).

Table 8. Correlation Between STEM Dimensions and Epistemological Beliefs

Variable	N	r	*p*
Mathematics	105	0.300	0.002*
Science	105	0.010	0.920
Engineering and Technology	105	0.123	0.213
21st Century Skills	105	0.186	0.058

Discussion and Conclusion

Attitudes and epistemological beliefs of gifted students in STEM fields (science, technology, engineering, mathematics) have been analysed in this research. Results, discussions and suggestions have been included following the examinations as to whether there is a differentiation in terms of STEM attitude dimensions "science, mathematics, engineering-technology and 21st century skills" and epistemological belief dimensions "authority and accuracy, information generation process, source of information, reasoning and variance of information".

According to the findings obtained in this study, it can be said that the epistemological beliefs of the students are at a traditional level in "authority and accuracy" and "source of information" dimensions. in today's traditionally-defined science approach; science is discovered by observation and experimentation, proceeds flawlessly due to its accumulated structure, produces objective results due to its structure independent of values, produces information that cannot be doubted for its accuracy, and does not deal with imagination, creativity and the limits (Ünal-Çoban & Ergin, 2008). Having traditional views in these dimensions may be the result of traditional educational practices. Therefore, 21st century education practices such as research-inquiry and STEM education should be included in the education of gifted students. It is seen that students have scientific epistemological belief at an advanced (contemporary) level in terms of "information generation process", "reasoning and variance of information" dimensions. In the contemporary understanding of science, though, scientific information is accepted as changeable truths, science research is believed to be value-laden like all other studies, and researchers are considered not to be completely objective (Mir & Watson, 2000). Aşut and Köksal (2015) found that gifted students showed a moderate level of development in terms of scientific epistemological beliefs. Schommer and Dunnell (1997) state that gifted students have a medium level of epistemological belief in the source of information, speed of learning, ability to learn and invariance of information dimensions. Therefore, it is seen that the scientific epistemological beliefs of gifted students should be strengthened with educational programs in educational environments. It has been found out that the scientific epistemological beliefs of gifted students show a statistically significant difference in favour of female students in "authority and accuracy" sub-dimensions. These findings are similar to the findings of Akgün and Gülmez (2015), Aydemir et al. (2013), Önen (2011). However; Conley et al. (2004) concluded that gender has no significant effect on epistemological belief. When the scientific epistemological beliefs of gifted students in various age groups are examined according to gender, it is observed that female students have more advanced epistemological beliefs than male students.

It has been observed that there are many studies on STEM attitudes of students (Aydın et al. 2017; Huang et al., 2020; Leonard et al., 2016; Nugent et al., 2010; Wieselmann et al., 2020). It is seen that students develop positive attitudes towards STEM, which is the most important change movement in the education field of the 21st century. Studies on STEM fields of gifted are inadequate. It is seen that gifted students have high interest in STEM dimensions in the research. These findings are similar to the observations of Tseng et al. (2013), who have stated that STEM activities significantly help students develop a positive attitude towards engineering and the positive attitudes are mostly seen towards engineering, then science, thirdly technology and finally mathematics. It has provided positive developments in the attitudes of STEM focused education schools towards students on STEM and STEM career fields (Guzey et al., 2014). In future researches, STEM career development processes can be examined as a result of STEM attitudes of gifted students. Aydın et al. (2017) state that students' attitudes towards STEM fields do not differ according to gender. However, in the research, when STEM attitudes have been examined in the context of gifted students, it has been observed that there is a difference in favour of male students. However, there was no difference in the 21st century skills dimension. The reason for this is that females are not so interested in the fields of engineering and technology (Mahoney, 2009), the number of the females is less in STEM environments (Murphy et al., 2007), and there are masculine objects in the STEM environments in general (Cheryan et al., 2009). Therefore, in the dimension of gifted students, it is necessary that the female students'

attitudes towards STEM should be supported by out-of-school activities. Wieselmann et al. (2020) stated that out-of-school STEM experiences can foster STEM interest and engagement among young girls.

There is a need for analysis that considers STEM disciplinary epistemologies to critically examine what is lost and gained through an integrated STEM approach (Reynante et al., 2020). STEM attitude structure is related to the epistemological beliefs and scientific methods. However, a scale that measures the scientific attitude towards STEM fields has not been developed yet. In the research, a statistically positive weak correlation has been found between STEM attitude and scientific epistemological belief values. As a result of the study, it has been concluded that students' epistemological beliefs can be a significant predictor of attitudes towards STEM. It is recommended that STEM' learning environments should be strengthened in order to develop the potentials of gifted individuals by using appropriate strategies for their needs.

Epistemological belief, information is a multi-dimensional concept (Hofer, 2001). Considering that epistemological beliefs and attitudes have a crucial effect on student learning, more detailed research on the sources of the beliefs and attitudes could be beneficial for finding ways to improve students' beliefs and attitudes (Bayraktar, 2019). As the attitudes towards scientific research can be changed over time, epistemological belief can also develop and change over time (Bendixen & Rule, 2004). Therefore, strengthening of science, attitudes towards scientific research and STEM attitudes will contribute to the development of students' epistemological beliefs. This two-way correlation will also contribute to strength to STEM career interest future needs of society. Different variables can be examined between STEM attitudes and epistemological beliefs, students who participate in STEM activities and students who do not. Studies to develop epistemological beliefs of gifted students can be conducted. Based on the weak relationship between STEM attitudes and epistemological belief, studies can be conducted to investigate.

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Statement of Publication Ethics

We declare that our research has no unethical problem. Ethical approval of this research was obtained with the decision of the scientific research and publication ethics committee of Muş Alparslan University dated 25/03/2020, number E4484/ 25.

Researchers' Contribution Rate

First author conceptualized the study and drafted the manuscript. Second author contributed with data collection and content analyses. First author reviewed drafts and contributed to manuscript revisions. All authors read and approved the final manuscript.

Conflict of Interest

We have no conflict of interest to declare

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