ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Research Article DOI: 10.33418/education.1510178

Determinants of Students' STEM Attitudes in Primary School: Reading Experience, Preschool Education and Career Choice

Duygu SARI[1]
Mehmet KATRANCI[2]
Uğur SARI[3]

[1] Şehit Osman Yıldırım Primary School, Kırıkkale, Turkey

[2] Kırıkkale University, Faculty of Education, Elementary Department, Kırıkkale, Turkey

[3] Kırıkkale University, Faculty of Education, Mathematics and Science Education Department, Kırıkkale, Turkey

Received Date 03.07.2024
Accepted Date 06.01.2025
Publication Date 10.02.2025

Corresponding author: Uğur SARI
E-mail: usari05@yahoo.com

Cite this article: Sarı, D., Katrancı, M., & Sarı, U. (2024). Determinants of students' STEM attitudes in primary school: Reading experience, preschool education and career choice. *Educational Academic Research, 56*, ….-…..

ABSTRACT

This study aims to examine primary school students' STEM attitudes in terms of some demographic characteristics and to reveal their determinants. 616 students who are in the fourth grade of primary school in a province in the Central Anatolia Region of Turkey participated in the study. The descriptive survey model was used in the study. The data of the study were collected through a personal information form and a STEM attitude scale. In the analysis of the data, Mann-Whitney U and Kruskal Wallis H tests were used together with the descriptive statistics results. In addition, the effect size value was calculated for all the obtained results. As a result of the study, it was determined that STEM attitudes differed significantly according to whether the students received preschool education, whether they followed science-themed children's magazines, the number of books they read per month, the type of book they liked to read and the profession they chose; however, the gender variable did not have a significant effect. According to the results, it was suggested that students should gain reading habits, follow science-themed magazines and be supported in reading science fiction books. In addition, the importance of educational policies aimed at expanding preschool education in order to increase interest in STEM fields was emphasized.

Keywords: Primary school, STEM attitude, reading experience, career choice

Introduction

STEM education is considered as a way to raise a highly equipped and educated workforce that will provide competitiveness in the 21st-century when globally competitive economies come to the fore. Therefore, educators, researchers and politicians are constantly making intense efforts to improve STEM education (Herro et al., 2019; Huang et al., 2022). However, studies show that despite the current interest and focus, students do not show sufficient interest in STEM fields in many countries, and this creates labour shortages in STEM fields (Lin et al., 2020). The number of students receiving engineering education is gradually decreasing in the USA and many European countries (Yazıcı et al., 2023). A similar trend is also being experienced in Turkey. In Turkey, interest in basic science fields such as physics, chemistry, biology and mathematics has decreased and the number of students has decreased significantly (CHE, 2022). Studies emphasize that if students want to focus on STEM fields, early intervention should be made in the education system to create students' interest in STEM fields (Yazıcı et al., 2023) and increase their career awareness (Moore & Richards, 2012). According to Unfried et al. (2015), students' attitudes towards STEM play a key role in their participation in STEM-related careers. Therefore, creating positive attitudes towards STEM fields is crucial for students to participate in the workforce in these fields (Knezek et al., 2013). In this regard, investigating students' STEM attitudes at an early age and revealing their determinants may provide important clues for their inclusion in the STEM workforce. This study aimed to examine primary school students' STEM attitudes in terms of various variables and to reveal their determinants. The study tried to answer the following questions:

1. What is the level of primary school students' STEM attitudes?

2. Do STEM attitudes differ significantly according to gender, pre-school education, children's magazines followed regularly, frequency of reading, type of books they like to read and career choice?

Theoretical Framework

STEM Attitude

Professions in the STEM field are necessary for a nation's technological innovation, economic growth, global competition and improvement of living standards and are considered "professions of the future" (Langdon et al., 2011). Therefore, students need to choose STEM-focused careers and join the workforce in these fields. Students' attitudes towards STEM are important in their participation in STEM-related careers (Unfried et al., 2015).

Students' attitudes towards the fields of science, technology, engineering and mathematics form their STEM attitudes. If students are not provided with the opportunity to apply their science experiences due to the abstract nature and complexity of science and are directed towards theoretical understanding rather than practical studies, low interest and negative attitudes towards science may occur (Tseng et al., 2013). According to George (2006), when students can apply the science knowledge they learn at school and understand the benefits of science in their daily lives, their interest in science may increase. Developing positive attitudes towards science will increase students' interest in science education and science-related careers. Studies show that students generally have positive attitudes towards technology, they find it interesting and prefer to work with new technologies, and they see technology as beneficial for society, life and medical sciences (Rees & Noyes, 2007; Tseng et al., 2013). Mathematics is generally found to be less popular among students than science, and it is stated that students' negative attitudes towards mathematics may increase with age (Tseng et al., 2013). However, according to some studies, students see mathematics as advantageous and express the concept of mathematics as an emphasis on calculating numbers and as a system and a way of thinking for daily life (Hillel & Perrett, 2006). On the other hand, mathematics is a difficult subject to learn. When learning support is insufficient in a mathematics curriculum, students' interest in learning can decrease and negative attitudes may occur (Stone et al., 2008). Students' attitudes towards science and mathematics, which are the basis of engineering, also affect their engineering attitudes (Tseng et al., 2013). According to Hilpert et al. (2008), students have positive attitudes towards engineering and are willing to pursue a career in engineering due to its contribution to society. Students' interests can have a direct impact on their attitudes towards engineering. Student attitudes and perceptions may also influence their choice of an engineering education. However, it has been stated that there has been a significant decline in students' interest and attitudes towards engineering (Flower, 2014). Osborne et al. (2003) emphasize that students' attitudes towards a course is a strong determinant for future career choice. Therefore, students need to have positive attitudes towards STEM disciplines from the first stages of education. Because students' positive attitudes towards science, mathematics, and engineering will affect their future career choices and lead them to related career fields. Studies show that students' STEM attitudes are related to some variables such as family and environment (Idris et al., 2023; Wiles & Levesque-Bristol, 2023). It is also emphasized that students' STEM attitudes can be improved with some practices (Sarı et al., 2018).

Literature Review

Studies show that students' positive attitudes towards STEM fields from an early age are essential for their participation in the STEM workforce in the future (Knezek et al., 2013; Sarı et al., 2018). Therefore, students' STEM attitudes are the subject of many studies. Ricks (2006) investigated the effectiveness of STEM education in secondary school students' career choices and determined that STEM education developed positive attitudes towards science lessons and was effective in students' choice of career in the STEM field. Xu and Lastrapes (2022) revealed that students' STEM attitudes have both direct and indirect effects on their career interests. Aydın et al. (2017) recorded in their study that the STEM attitudes of four-eight-grade students did not differ according to demographic characteristics such as gender, education in a private or public school and parents' education level, but there was a significant difference according to the region they lived in and their career preferences. Özyurt et al. (2018) determined that primary school students' STEM attitudes differ significantly in favour of experimenting, using laboratories, using technological products such as tablets and smart boards in lessons, and carrying out project work. Kucuk and Sisman (2020) investigated the relationship between students' STEM attitudes and gender. Lane et al. (2022) reported gender differences in women's STEM attitudes and participation in STEM careers in many countries, often to the detriment of women. Sarı et al. (2018) determined that STEM applications significantly increased secondary school students' attitudes towards STEM disciplines, their STEM career perceptions and their professional interest in STEM fields. Arslan (2023) found that there was a moderate positive relationship between middle school students' book reading habits and their attitudes towards STEM. Idris et al. (2023) investigated the impact of socioeconomic class, family background, and gender on students' STEM interests and desires. It has been determined that socioeconomic factors affect students' STEM interests. It has also been determined that parents'

education and profession have a significant impact on children's perceptions of STEM professions and their self-confidence in these fields. Yetkin and Aküzüm (2022) examined the relationship between learning conceptions and STEM attitudes of fourth-grade primary school students and determined that learning conceptions were a significant predictor of attitudes towards STEM.

When the studies discussed above are evaluated, some gaps emerge. While studies on STEM attitudes are concentrated mostly at secondary school (Lin et al., 2020; Sarı et al., 2018; Sellami et al., 2023; Yazıcı et al., 2023) and university levels (Idris et al., 2023; Wiles & Levesque-Bristol, 2023), studies on primary school students are limited. While existing studies generally focus on the effect of STEM education on STEM attitudes (Sarı et al., 2018; Uğraş, 2024), some have investigated the relationship between STEM attitudes and some demographic characteristics (Canbazoğlu & Tümkaya, 2020; Öztürk, 2017; Özyurt et al., 2018). It seems that the relationships between primary school students' STEM attitudes and reading habits such as book reading frequency, the type of books they like to read, and scientific journal subscriptions have not been investigated. Investigating students' STEM attitudes at an early age and revealing some of their determinants will provide important clues for their inclusion in the STEM workforce.

Method

Research Model

This study was conducted based on the descriptive survey model, which is one of the quantitative research methods. The survey model enables the quantitative description of trends, attitudes or opinions in the universe through studies conducted on a sample selected from the universe (Creswell, 2013). The descriptive survey model is a research approach that aims to describe an existing situation as completely and carefully as possible, rather than focusing on the cause and effect relationship. In this approach, the researched subject, individual or object is defined within its own conditions and as it is; evaluation is made within the framework of standards and the connections between events are attempted to be revealed (Çepni, 2009; Johnson & Christensen, 2014).

Population and Sample

The population consists of students who continue their education in the fourth-grade of primary school in a province in the Central Anatolia Region of Turkey in the spring semester of 2021. According to the information obtained, the population of students is 2856. According to Johnson and Christensen (2014, p.323), a sample size of 341 people is sufficient for a study population of 3000 people at a confidence interval of .95. Simple random sampling technique, one of the random sampling methods, was used to determine the sample. Simple random sampling is a sampling technique in which every member of the population has an equal chance of being selected for the study (Johnson & Christensen, 2014, p.304). In this regard, a total of 616 fourth-grade primary school students (314 boys and 302 girls) from 17 public schools in the city center participated in the research voluntarily.

Data Collection Tools

The data were collected using a Personal Information Form and the STEM Attitude Scale.

Personal Information Form: The form prepared by the researchers includes questions about the students' gender, the number of books read in a month, the type of books they like to read, the children's magazine they follow regularly, and their profession choices.

STEM Attitude Scale: The STEM Attitude Scale, developed by Unfried et al. (2015) and adapted to Turkish by Öztürk (2017), was used to determine students' attitudes towards STEM. The scale consists of 37 items with four sub-dimensions: Mathematics (8 items), Science (9 items), Engineering and Technology (9 items) and 21st-Century Learning (11 items). The scoring of the scale is in Likert type, with ratings such as "I strongly agree", "I agree", "I am undecided", "I disagree" and "I strongly disagree". The lowest score that can be obtained from the scale is 37, and the highest score is 185. In the study of adapting the scale to Turkish, it was applied to 453 students in the fourth-grade of primary school and the Cronbach Alpha reliability coefficient was determined as .84 (Öztürk, 2017). The Cronbach Alpha reliability coefficient calculated within the scope of this study is .93.

The ethical process in the study was as follows:

- Ethics committee approval was obtained from Kırıkkale University Local Ethics Committee (Date: 18.02.2021, Number: E-2021-02.02)
- Informed consent has been obtained from the participants.

Data Collection and Analysis

Data were collected during the distance education process due to the COVID-19 outbreak. First, school administrators and primary school fourth-grade teachers were informed about the study. The scales were transferred to Google Forms, and the online link was delivered to the students through school administrators and teachers. Before participating, students were asked to confirm the study purpose, the approximate response time of the scales, and the page stating that they participated in the study voluntarily. Thus, students were enabled to participate in the study voluntarily.

The data were transferred to the SPSS program after the data collection process. During the data analysis process, firstly, skewness and kurtosis values, Kolmogorov-Smirnov test results and histogram graphs were examined to determine whether the scores received by the students from the sub-dimensions and the overall STEM Attitude Scale showed a normal distribution. Kolmogorov-Smirnov test results are in Table 1.

Table 1.
Normality Analysis Results for Study Data

Scale	Dimension	N	Z	*p*	Skewness	Kurtosis
STEM Attitude Scale	Maths	613	.096	.000*	-.670	-.055
	Science	613	.053	.000*	-.400	.311
	Engineering and Technology	613	.089	.000*	-.623	.582
	21st-Century Learnings	613	.103	.000*	-1.520	4.653
	Overall Scale	613	.047	.000*	-.760	1.933

It was determined that the Kolmogorov-Smirnov test results were significant, and the histogram graphics were far from normal distribution. It was accepted that the data did not show a normal distribution and non-parametric statistical tests were used in the analyses. Whether students' STEM attitudes differ according to gender and preschool education status was examined with the Mann-Whitney U test, and whether these attitudes differ according to the children's magazine followed regularly, the number of books read in a month, the type of books liked and their career choice was examined with the Kruskal Wallis H test. If there is a significant difference in the Kruskal Wallis H test, pairwise comparisons were made with the Mann-Whitney U test to determine the source of the difference, and Bonferroni correction was used in these comparisons. Bonferroni correction is determined by the significance level/number of groups (p/k) formula (VanderWeele & Mathur, 2019). In addition, the eta-squared (η2) value was calculated, which is called the effect size for all comparisons and shows how much of the total variance in the dependent variable, the independent variable or factor explains. This value varies between 0.00 and 1.00, and η2 values of .01, .06 and .14 are interpreted as "small", "medium" and "large" effect sizes, respectively (Cohen, 1988).

Results

The findings obtained from data in line with the objectives of the study are presented in order with the research questions. Students' STEM attitude scale scores show that STEM attitude is at a high level in the overall and sub-dimensions of the scale. In evaluating the scores that students received from the scales, the formula suggested by Tekin (2000) was used: Range Width = Array Width / Number of Groups to be Made.

Table 2.
Students' STEM Attitude Level

Dimension	N	Lowest	Highest	$\overline{X}$	s	Level
Maths	616	10	40	31.80	6.09	High
Science	616	17	45	34.48	5.92	High
Engineering and Technology	616	14	55	46.46	5.98	High
21st-Century Learnings	616	14	55	46.48	5.97	High
Overall Scale	616	84	185	147.39	18.25	High

The Mann-Whitney U test result of STEM attitude according to gender shows that female students' STEM attitude scores are higher than male students in all sub-dimensions except the science sub-dimension and in the overall scale (Table 3). However, this difference is not statistically significant. It can be said that gender is not an effective variable on STEM attitudes.

Table 3.
Mann-Whitney U Test Results of Students' STEM Attitudes According to Gender

Dimension	Gender	N	Rang Average	Total of Rows	U	*p*
Maths	Male	314	298.87	93845.5	44390.5	.170
	Female	302	318.51	96190.5		
Science	Male	314	315.87	99184.5	45098.5	.294
	Female	302	300.83	90851.5		
Engineering and Technology	Male	314	322.04	101119.5	43163.5	.054
	Female	302	394.43	88916.5		
21st-Century Learnings	Male	314	319.50	99365.0	42451.0	.054
	Female	302	392.00	87601.0		
Overall Scale	Male	314	301.17	94567.0	45112.0	.297
	Female	302	316.12	95469.0		

According to the Mann-Whitney U test results given in Table 4, students' STEM attitudes show a significant difference in favour of students receiving pre-school education in all sub-dimensions and overall scale.

According to the effect size values, it can be said that the effect is small and that pre-school education has a positive effect, albeit at a low level, on students' STEM attitudes.

Table 4.
Mann-Whitney U Test Results of STEM Attitude According to Pre-School Education

Dimension	Pre-School Education	N	Rank Average	Total of Rows	U	*p*	Effect Size (η^2)
Maths	Yes	494	327.20	161635.5	20897.5	.000*	.045
	No	122	232.79	28400.5			
Science	Yes	494	325.55	160823.5	21709.5	.000*	.037
	No	122	239.45	29212.5			
Engineering and Technology	Yes	494	323.48	159800.0	22733.0	.000*	.029
	No	122	247.84	30236.0			
21st-Century Learnings	Yes	494	320.78	157181.0	22404.0	.000*	.031
	No	122	246.16	29785.0			
Overall Scale	Yes	494	329.04	162546.5	19986.5	.000*	.054
	No	122	225.32	27489.5			

Whether STEM attitudes differ depending on the children's magazine followed regularly was analysed with the Kruskal Wallis H test. Analyses were carried out on data obtained from 147 students who regularly followed children's magazines (Table 5). Students' STEM attitude scores show significant differences depending on the children's magazine followed. Pairwise comparisons were made with the Mann-Whitney U test to determine the source of this difference. Bonferroni correction was used in these comparisons, and the significance level limit was accepted as .016. As a result of the analysis, it was observed that the significant difference in all sub-dimensions and the overall scale was between the students who follow "Bilim Çocuk" magazine and the students who follow other magazines, in favour of the students who follow "Bilim Çocuk" magazine. In addition, it was determined that there was a significant

difference in the science sub-dimension and the overall scale between those who follow "TRT Çocuk" magazine and those who follow other magazines, in favour of the students who follow "TRT Çocuk" magazine. Effect size values show that the effect in all sub-dimensions and the overall scale is at a small effect level. According to these findings, it can be said that children's magazines followed regularly are effective on STEM attitudes.

Table 5.
Kruskal Wallis-H Test Results of STEM Attitudes According to Children's Magazine Followed Regularly

Dimension	Children's Magazine	N	Rank Average	Sd	X^2	*p*	Difference	Effect Size (η^2)
Maths	1-Bilim Çocuk	63	87.21	2	15.467	.000*	1-3	.024
	2-TRT Çocuk	25	79.66					
	3-Other	59	57.49					
Science	1-Bilim Çocuk	63	88.73	2	19.364	.000*	1-3 2-3	.03
	2-TRT Çocuk	25	80.56					
	3-Other	59	55.49					
Engineering and Technology	1-Bilim Çocuk	63	86.13	2	12.320	.002*	1-3	.018
	2-TRT Çocuk	25	77.76					
	3-Other	59	59.45					
21st-Century Learnings	1-Bilim Çocuk	63	83.16	2	10.525	.005*	1-3	.016
	2-TRT Çocuk	25	75.06					
	3-Other	59	58.72					
Overall Scale	1-Bilim Çocuk	63	93.79	2	30.362	.000*	1-3 2-3	.048
	2-TRT Çocuk	25	77.38					
	3-Other	59	51.43					

Kruskal Wallis H test results for the relationship between STEM attitudes and students' the number of books read in a month are given in Table 6. It was determined that the scores in all sub-dimensions of the scale and the overall scale showed significant differences depending on the number of books the students read in a month. Rank average scores show that as the number of books read increases, students' STEM attitudes also increase. Pairwise comparisons were made with the Mann-Whitney U test, and the significance level was accepted as .005 in these comparisons. It was determined that the significant difference in the STEM attitude scale overall and in the sub-dimensions of the scale was in favour of students who read four or more books in a month and those who read more books among the groups that did not read books, read one book and read two books. It was observed that there was a significant difference between the students who read three books a month and the students who read one book in favour of those who read more books in all sub-dimensions and the overall scale except for the maths sub-dimension.

In addition, it was determined that there was a significant difference in the sub-dimensions of engineering and technology and 21st-century learning between students who read four or more books in a month and students who read three books in favour of those who read more books. Effect size values show that the effect in the mathematics sub-dimension is small, while the effect in other sub-dimensions and the scale in general is medium. According to these findings, it can be said that reading books contributes significantly to students' STEM attitudes.

Table 6.
Kruskal Wallis-H Test Results According to STEM Attitude and Book Reading Frequency

Dimension	Number of Books Read Monthly	N	Rank Average	Sd	X^2	*p*	Difference	Effect Size (η^2)
Maths	1- not read	29	238.64	4	30.22	.000*	1-5 2-5 3-5	.044
	2- one book	117	266.83					
	3- two books	103	268.22					
	4- three books	109	312.04					
	5- four books and more	258	349.83					
Science	1- not read	29	251.36	4	40.78	.000*	1-5 2-4 2-5 3-5	.062
	2- one book	117	240.62					
	3- two books	103	276.85					
	4- three books	109	318.18					
	5- four books and more	258	354.25					
Engineering and Technology	1- not read	29	206.43	4	50.14	.000*	1-5 2-4 2-5 3-5 4-5	.077
	2- one book	117	237.57					
	3- two books	103	298.23					
	4- three books	109	300.58					
	5- four books and more	258	359.58					
21st-Century Learnings	1- not read	29	204.36	4	52.38	.000*	1-5 2-4 2-5 3-5 4-5	.081
	2- one book	117	232.37					
	3- two books	103	296.45					
	4- three books	109	297.77					
	5- four books and more	258	357.66					
Overall Scale	1- not read	29	215.52	4	48.69	.000*	1-5 2-4 2-5 3-5	.075
	2- one book	117	241.16					
	3- two books	103	278.09					
	4- three books	109	314.41					
	5- four books and more	258	359.13					

According to the analysis results given in Table 7, the type of books that students like to read is a variable that creates a significant difference on STEM attitude. When the rank average scores are examined, it is noted that the highest score in the STEM attitude scale belongs to the students who prefer science fiction, and the lowest score belongs to the students who prefer the story. The groups showing differences in the pairwise comparisons between groups made with the Mann-Whitney U test (significance level was accepted as .005) are given in Table 7. The effect size in the overall scale is medium, and the effect size in the sub-dimensions is small. According to these findings, it can be said that the type of book preferred to read significantly affects STEM attitude and that reading science fiction books contributes the most to STEM attitude.

Table 7.
Kruskal Wallis-H Test Results of Students' STEM Attitudes According to the Type of Books They Like to Read

Dimension	Type of books	N	Rank Average	Sd	X^2	*p*	Difference	Effect Size (η^2)
Maths	1- Fairytale	36	306.74	4	38.91	.000*	2-3 2-4 2-5 3-4	.059
	2- Story	150	246.30					
	3- Science Fiction	46	399.76					
	4- Adventure	355	315.60					
	5- Other	29	400.74					
Science	1- Fairytale	36	296.42	4	37.97	.000*	1-3 2-3 2-4 3-4	.057
	2- Story	150	247.99					
	3- Science Fiction	46	418.96					
	4- Adventure	355	317.44					
	5- Other	29	351.88					
Engineering and Technology	1- Fairytale	36	282.88	4	29.17	.000*	1-5 2-3 2-4 2-5	.043
	2- Story	150	253.26					
	3- Science Fiction	46	368.01					
	4- Adventure	355	319.39					
	5- Other	29	398.33					
21st-Century Learnings	1- Fairytale	36	280.32	4	28.59	.000*	1-5 2-3 2-4 2-5	.042
	2- Story	150	250.94					
	3- Science Fiction	46	362.17					
	4- Adventure	355	317.25					
	5- Other	29	394.74					
Overall Scale	1- Fairytale	36	279.46	4	54.87	.000*	1-3 2-3 2-4 2-5 3-4	.085
	2- Story	150	234.95					
	3- Science Fiction	46	432.75					
	4- Adventure	355	320.94					
	5- Other	29	375.62					

According to the results of the Kruskal Wallis-H Test to determine the effect of students' career choice, it was determined that career choice caused a significant difference in the sub-dimensions of the STEM attitude scale and the overall scale (Table 8). Pairwise comparisons were made with the Mann-Whitney U test (the significance level was accepted as .0023) to determine the source of the significant difference, and Table 8 shows among which groups there was a difference. According to the rank average scores, it is seen that the highest score in the STEM attitude scale overall and its sub-dimensions belongs to the engineer/architect profession group, and the lowest score belongs to the group preferring police/military/security professions. There is a significant difference between students preferring the engineer/architect profession and other groups in favour of those preferring the engineer/architect profession. The effect size values are small in the engineering and technology and 21st-century learning sub-dimensions, and medium in the mathematics and science sub-dimensions and the overall scale. According to these findings, it can be stated that career choice is an effective variable on STEM attitude.

Table 8.
Kruskal Wallis-H Test Results of Students' STEM Attitudes According to Their Career Choice

Dimension	Professions	N	Rank Average	Sd	X^2	*p*	Difference	Effect Size (η^2)
Maths	1- The Field of Health	191	337.11	6	55.684	.000*	1-4 2-3 3-4 3-5 3-7 4-5 4-7	.083
	2- Teacher	69	265.14					
	3- Engineer/Architect	80	397.48					
	4- Police/Soldier	95	215.76					
	5- The Fields of Law	55	307.73					
	6- The Field of Sport	34	321.74					
	7- Other	92	295.58					
Science	1- The Field of Health	191	340.21	6	56.855	.000*	1-4 1-6 2-4 3-4 3-5 3-6 4-7	.085
	2- Teacher	69	314.26					
	3- Engineer/Architect	80	389.02					
	4- Police/Soldier	95	219.59					
	5- The Fields of Law	55	264.46					
	6- The Field of Sport	34	228.28					
	7- Other	92	316.10					
Engineering and Technology	1- The Field of Health	191	320.08	6	14.129	.028*	1-4 3-4	.015
	2- Teacher	69	298.12					
	3- Engineer/Architect	80	339.31					
	4- Police/Soldier	95	251.32					
	5- The Fields of Law	55	312.81					
	6- The Field of Sport	34	301.63					
	7- Other	92	324.46					
21st-Century Learnings	1- The Field of Health	191	317.01	6	14.002	.030*	1-4 3-4	.015
	2- Teacher	69	295.43					
	3- Engineer/Architect	80	336.23					
	4- Police/Soldier	95	248.97					
	5- The Fields of Law	55	309.91					
	6- The Field of Sport	34	307.61					
	7- Other	92	321.45					
Overall Scale	1- The Field of Health	191	325.76	6	62.394	.000*	1-3 1-4 2-3 3-4 3-5 3-6 3-7 4-7	.094
	2- Teacher	69	269.01					
	3- Engineer/Architect	80	419.27					
	4- Police/Soldier	95	219.33					
	5- The Fields of Law	55	278.29					
	6- The Field of Sport	34	293.32					
	7- Other	92	321.70					

Discussion

Primary school students' STEM attitudes were examined in terms of some demographic characteristics in this study. It was determined that the students participating in the study had a high level of STEM attitude. According to Unfried et al. (2015), students' attitudes towards STEM play a key role in their participation in STEM careers. In this regard, the finding is important in terms of students' future participation in the STEM workforce. In the study, it was determined that STEM attitudes did not differ significantly

by gender. Supporting this finding, it has been reported in the literature that students' gender is not related to STEM attitudes (Brown et al., 2016; Canbazoğlu & Tümkaya, 2020). On the other hand, Christensen and Knezek (2017) determined that male students' STEM attitudes were higher than female students. Unfried et al. (2014) found that the attitudes of male and female students towards engineering and technology were significantly different in favor of male students. Therefore, it can be said that the results and literature findings vary.

The study found that students who received pre-school education had a statistically significantly higher STEM attitude than those who did not. It can be said that the activities in the fields of science, mathematics and visual arts in the preschool education curriculum may have positively affected the STEM attitude. Preschool students have a very curious structure as a characteristic of the period. The science, mathematics and art activities carried out in this curious period may have developed their imagination and creativity while also increasing their interest and attitudes towards the relevant fields. Thus, the STEM attitude may have been acquired as a common reflection of the attitudes towards the fields of science, mathematics, technology and engineering. According to Duffy (1998), eighty per cent of human development is completed in the first six years of life, which is defined as the preschool period. For this reason, it is emphasized that pre-school education can be effective on the personal characteristics of the individual that will emerge in the future (Zigler & Muenchow, 1992). The American National Research Council [NRC] (2011) clearly emphasizes the importance of pre-school education for a successful STEM education. Considering the importance of skills such as imagination, curiosity, creativity and critical thinking in STEM fields, it is stated that such an understanding should start from the preschool period (Chesloff, 2013). Research indicates that pre-school education, which is stated to be very effective in the formation of an individual's characteristics, supports the development of reasoning, creativity and imagination, and plays an important role in gaining self-confidence. It is also emphasized that the education received in the pre-school period is important in terms of children gaining social skills and academic success in their future lives (Pagani et al., 2003; Zigler & Muenchow, 1992).

The relationship between students' reading experiences, such as book reading frequency, book type preferred and magazines followed regularly, and STEM attitudes were evaluated in the study. It was determined that the STEM attitudes of the students who regularly follow "Bilim Çocuk" magazine and "TRT Çocuk" magazine were at a higher level than those who followed other magazines, and there was a significant difference between them. It was determined that students' following magazines regularly, especially science magazines, was one of the factors that positively affected STEM attitudes. The aim of science-themed magazines, such as "Bilim Çocuk" magazine, is to instil a love of science at young ages, to arouse the desire to do research, ask questions, wonder and read, to develop scientific creativity and to encourage invention. In such magazines, current news from the world of science and technological developments, introduction of scientists, scientific activities and information about space are given with colours, lines, cartoons and various visuals that will attract the attention of students (https://bilimcocuk.tubitak.gov.tr). It can be thought that these science-themed contents affect children positively and create interest and positive attitudes towards science, mathematics, technology and engineering. Therefore, it can be said that following science-themed children's magazines contributes to the development of positive attitudes towards STEM fields in students. In his study, Ekici (2017) determined that students who follow science magazines have higher perceptions of inquiry, and stated that science-themed magazines arouse curiosity and direct students to think, and thus, the fact that they can learn information about the events they are curious about while having fun is the reason for the development in their perception of inquiry. Kerem (2019) found in his study that fourth-grade students' STEM attitude levels made a statistically significant difference depending on whether they subscribed to or followed a scientific journal, and that the attitudes of students who subscribed to a scientific journal were higher.

It was determined that another factor affecting students' STEM attitudes regarding their reading experiences was the book type preferred. While the STEM attitude of those who preferred to read science fiction books was found to be at the highest level, those who preferred the story were found to be at the lowest level. It has been determined that the type of book preferred to read significantly affects STEM attitudes and that science fiction makes the most contribution. This situation is parallel to another result of the study, which is the positive effect of following science-themed magazines on STEM attitudes. Science fiction writing is based on science and reveals the possibility of stories and extraordinary things about the near or distant future with the elements of science and technology. When technology, science, creative thinking, imagination and innovative thinking are considered as the basic concepts of science fiction, it can be thought that these may positively affect students' STEM attitudes. Because the concepts of

creative thinking, imagination and innovative thinking are directly related to the fields of science, engineering and technology (Şahin et al., 2024). The use of relevant skills can only be possible with the use of science, engineering and technology disciplines. Therefore, the fact that these disciplines form STEM is the reason for the positive contribution of science fiction books to STEM attitudes. Karadeniz and Değirmençay (2020) determined that science fiction stories were effective on students' creative thinking skills.

According to findings, the frequency of reading books significantly affects STEM attitudes. It was determined that as the number of books students read in a month increased, their STEM attitudes also increased. Reading is one of the most effective elements in an individual's intellectual, creative and self-confident growth (Ortaş, 2014). According to the literature, reading books contributes to the formation of new ideas in students, the development of thinking skills (Taylor, 2006; Zulela & Rachmadtullah, 2018), and the increase in the level of understanding (Moll and Bus, 2011). There are findings in some studies that reading improves critical thinking and problem-solving skills (Fuchs & Fuchs, 2002; Österholm, 2007). Supporting these effects on reading, it can be evaluated that students' reading levels also contribute significantly to their STEM attitudes.

Another demographic feature that was determined to be related to students' STEM attitudes was their career choice. It was determined that the STEM attitudes of students who preferred the engineering/architecture professions was at the highest level, while attitude of students preferring the police/military professions was at the lowest level. In general, engineering/architecture professions can be considered as innovation-oriented professions that require problem solving, critical thinking, creative thinking and using imagination compared to other professional groups. This group is among the profession groups that appeal to STEM fields. Therefore, it can be considered as an expected situation that students considering choosing these professions have an interest and positive attitude towards mathematics, science, technology and engineering fields. In addition, the high STEM attitude of these students may give them an advantage if they receive engineering education in the future. These results are similar to the findings in the literature (Aydın et al., 2017). On the other hand, Canbazoğlu and Tümkaya (2020) determined in their study that students' STEM attitudes did not differ according to their career choices.

Conclusion and Recommendations

This study shows that for fourth-grade primary school students, receiving pre-school education and following science-themed magazines, the number of books read in a month, type of books read, and preferred profession are determinants of STEM attitude, while gender doesn't affect STEM attitudes.

According to the results, educational policies should be designed to expand pre-school education in order to increase interest in STEM fields considering that pre-school education contributes to STEM attitudes.

Considering the positive reflections of book reading frequency, following science-themed magazines and reading science fiction books on STEM attitudes, students should be encouraged to acquire reading habits, to follow science-themed magazines, and to read science fiction books. In addition, these publications can be included in school libraries to ensure that students are introduced to such publications at the primary school level and can easily access such publications.

This study is limited to quantitative data. Similar studies can be conducted using mixed or experimental designs where quantitative data can be supported by qualitative data.

Ethics Committee Approval: Ethics committee approval was obtained from Kırıkkale University Local Ethics Committee (Date: 18.02.2021, Number: 2021-02/02)
Informed Consent: Consent was obtained from participants
Peer-review: Externally peer-reviewed.
Author Contributions: Concept-DS-MK; Design-DS-MK-US; Supervision-MK-US; Resources-DS; Data Collection and/or Processing-DS; Analysis and/or Interpretation-DS-MK; Literature Search-DS-MK; Writing Manuscript-DS-MK-US; Critical Review-MK-US
Conflict of Interest: The authors have no conflicts of interest to declare.
Financial Disclosure: The authors declared that this study has received no financial support.

References

Arslan, A. (2023). Examination of reading habits and stem attitudes of secondary school students. *Educational Academic Research*, *49,* 23-38. https://doi.org/10.5152/AUJKKEF.2023.1039309

Aydın, G., Saka, M., & Guzey, S. (2017). Science, technology, engineering, mathematic (STEM) attitude levels in grades 4th-8th. *Mersin University Journal of the Faculty of Education*, *13*(2), 787-802. https://doi.org/10.17860/mersinefd.290319

Brown, P. L., Concannon, J. P., Marx, D., Donaldson, C. W., & Black, A. (2016). An examination of middle school students' STEM self-efficacy with relation to interest and perceptions of STEM. *Journal of STEM Education: Innovations and Research, 1*7(3), 27-38.

Canbazoğlu, H. B., & Tümkaya, S. (2020). Evaluation of elementary school fourth grade students' science, technology, engineering, mathematics (STEM) attitudes in terms of various variables. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *11*(1), 188-209.

CHE (2022) Basic sciences meeting report (Publication No. 2022/1).https://www.yok.gov.tr/Documents/Yayinlar/Yayinlarimiz/2022/04-temel-bilimler-toplantisi-raporu.pdf

Chesloff, J. D. (2013). STEM education must start in early childhood. *Education Week*, *32*(23), 27-32.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Academic Press.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage.

Çepni, S. (2009). *Introduction to research and project studies* (4th ed.). Erol Ofset.

Duffy, B. (1998). *Fostering creative development: A curriculum development handbook for early childhood educators stoke on trent*. Trentham Books.

Ekici, D. İ. (2017). An investigation on the factors affecting the scientific inquiry skills perceptions of secondary students. *Kastamonu Education Journal*, *25*(2), 497-516.

Flower III, A. M. (2014). Building an academic community: Minority serving institutions and how they influence students pursuing undergraduate degrees in STEM. *Multicultural Learning and Teaching*, *9*(2), 187-201.

Fuchs, L. S., & Fuchs, D. (2002). Mathematical problem-solving profiles of students with mathematics disabilities with and without comorbid reading disabilities. *Journal of Learning Disabilities*, *35*(6), 564-574.

George, R. (2006). A cross-domain analysis of change in students' attitudes toward science and attitudes about the utility of science. *International journal of science education*, *28*(6), 571-589.

Herro, D., Quigley, C., & Cian, H. (2019). The challenges of STEAM instruction: Lessons from the field. *Action in Teacher Education*, *41*(2), 172-190. https://doi.org/10.1080/01626620.2018.1551159

Hillel, J., & Perrett, G. (2006). Undergraduate students' conceptions of mathematics: An international study. *International Journal of Science and Mathematics Education, 5*, 439-459.

Hilpert, J., Stump, G., Husman, J., & Kim, W. (2008). *An exploratory factor analysis of the Pittsburgh freshman engineering attitudes survey.* The 386th ASEE/IEEE Frontiers in Education Conference, New York.

Huang, B., Jong, M. S. Y., Tu, Y. F., Hwang, G. J., Chai, C. S., & Jiang, M. Y. C. (2022). Trends and exemplary practices of STEM teacher professional development programs in K-12 contexts: A systematic review of empirical studies. *Computers and Education*, *189*(2022), 1-24. https://doi.org/10.1016/j.compedu.2022.104577

Idris, R., Govindasamy, P., Nachiappan, S., & Bacotang, J. (2023). Examining moderator factors influencing students' interest in STEM careers: The role of demographic, family and gender. *International Journal of Academic Research in Progressive Education and Development*, *12*(2), 2298-2312. http://dx.doi.org/10.6007/IJARPED/v12-i2/17609

Johnson, R. B., & Christensen, L. (2014). *Educational research: Quantitative, qualitative and mixed approaches*. Sage.

Karadeniz, E., & Değirmençay, Ş. A. (2020). The effect of the science-fiction books on arousing curiosity about science in secondary school students. *Journal of Turkish Science Education*, *17*(2), 225-241.

Kerem, İ. (2019). *Investigation of the relationship between the disciplined mind attributes and STEM attitudes of elementary school 4th grade students (Afyonkarahisar sampling)* (Publication No. 554383) [Masters's thesis, Afyon Kocatepe University-Afyon] Council of Higher Education National Thesis Centre.

Knezek, G., Christensen, R., Tyler-Wood, T., & Periathiruvadi, S. (2013). Impact of environmental power monitoring activities on middle school student perceptions of STEM. *Science Education International*, *24*(1), 98-123.

Kucuk, S., & Sisman, B. (2020). Students' attitudes towards robotics and STEM: Differences based on gender and robotics experience. *International Journal of Child-Computer Interaction*, *23*, 100167.

Lane, C., Kaya-Capocci, S., Kelly, R., O'Connell, T., & Goos, M. (2022). Fascinating or dull? Female students' attitudes towards STEM subjects and careers. *Frontiers in Psychology*, *13*, 959972.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Dom, M. (2011). *STEM: Good jobs now and for the future.* ESA Issue Brief 03-11. U.S. Department of Commerce, Economics and Statistics Administration.

Lin, K. Y., Hsiao, H. S., Williams, P. J., & Chen, Y. H. (2020). Effects of 6E-oriented STEM practical activities in cultivating middle school students' attitudes toward technology and technological inquiry ability. *Research in Science & Technological Education*, *38*(1), 1-18. https://doi.org/10.1080/02635143.2018.1561432.

Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. Psychological Bulletin, *137*(2), 267-296.

Moore, T., & Richards, L. G. (2012). P-12 Engineering Education Research and Practice. *Advances in Engineering Education*, *3*(2), 1-9.

National Research Council [NRC]. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. National Academies Press.

Ortaş, İ. (2014). Comparison of Turkey and the world of reading book value and their ımpact on our social life. *Turkish Librarianship*, *28*(3), 323-337.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Österholm, M. (2007). A reading comprehension perspective on problem solving. C. Bergsten and B. Grevholm (Eds.), *Developing and researching quality in mathematics teaching and learning*, Proceedings of MADIF 5, the 5th Swedish Mathematics Education Research Seminar (pp. 136-145). SMDF.

Öztürk, M. (2017). *The research of the 4th grade teachers' and students' efficacy beliefs and attitudes toward STEM education* (Publication No. 485418) [Master's thesis, Ege University-İzmir]. Council of Higher Education National Thesis Centre.

Özyurt, M., Kayiran, B. K., & Başaran, M. (2018). Analysis of primary school students' attitudes towards STEM in terms of various variables. *Turkish Studies, 13*(4), 65-82. http://dx.doi.org/10.7827/TurkishStudies.12700

Pagani, L., Larocque, D., Tremblay, R., & Lapointe, P. (2003). The impact of junior kindergarten on behaviour in elementary school children. *International Journal of Behavioral Development*, *27*(5), 423-427.

Rees, H., & Noyes, J. M. (2007). Mobile telephones, computers, and the internet: Sex differences in adolescents' use and attitudes. *CyberPsychology & Behavior*, *10*(3), 482-484.

Ricks, M. M. (2006). *A study of the impact of an informal science education program on middle school students' science knowledge, science attitude, STEM high school and college course selections, and career decisions* (Publication No. 3245344) [Doctoral dissertation, The University of Texas at Austin] ProQuest Dissertations and Theses Global.

Sarı, U., Alıcı, M., & Şen, Ö. F. (2018). The effect of STEM instruction on attitude, career perception and career interest in a problem-based learning environment and student opinions. *The Electronic Journal for Research in Science & Mathematics Education*, *22*(1), 1-21.

Sellami, A. L., Al-Rakeb, N. A., & Tok, E. (2023). Secondary school students' interest in STEM careers in Qatar. *Education Sciences*, *13*(4), 369.

Stone, J. R., I. I. I., Alfeld, C., & Pearson, D. (2008). Rigor and relevance: Enhancing high school students' math skills through career and technical education. *American Educational Research Journal, 45*(3), 767–795.

Şahin, E., Sarı, U., & Şen, Ö. F. (2024). STEM professional development program for gifted education teachers: STEM lesson plan design competence, self-efficacy, computational thinking and entrepreneurial skills. *Thinking Skills and Creativity*, *51*, 101439. https://doi.org/10.1016/j.tsc.2023.101439.

Taylor, R. T. (Ed.). (2006). *Improving reading, writing, and content learning for students in grades 4-12*. Corwin Press.

Tekin, H. (2000). Measurement and evaluation in education. Yargı Publishing.

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, *23*, 87-102.

Uğraş, M. (2024). The effects of STEM activities on STEM attitudes, scientific creativity and motivation beliefs of the students and their views on STEM education. *International Online Journal of Educational Sciences*, *10*(5), 165-182. http://dx.doi.org/10.15345/iojes.2018.05.012

Unfried, A., Faber, M., Stanhope, D. S., & Wiebe, E. (2015). The development and validation of a measure of student attitudes toward science, technology, engineering, and math (S-STEM). *Journal of Psychoeducational Assessment*, *33*(7), 622-639. https://doi.org/10.1177/0734282915571160

VanderWeele, T. J., & Mathur, M. B. (2019). Some desirable properties of the Bonferroni correction: Is the Bonferroni correction really so bad? *American journal of epidemiology*, *188*(3), 617-618. https://doi.org/10.1093/aje/kwy250

Wiles, B., & Levesque-Bristol, C. (2023). Motivation and achievement in undergraduate STEM calculus: Applying self-determination theory to examine the differential impact of learning environments across demographic groups. *School Science and Mathematics*, *123* 154-167. https://doi.org/10.1111/ssm.12590

Yazıcı, Y. Y., Hacıoğlu, Y., & Sarı, U. (2023). Entrepreneurship, STEM attitude, and career interest development through 6E learning byDeSIGN™ model based STEM education. *International Journal of Technology and Design Education*, *33*(4), 1525-1545. https://doi.org/10.1007/s10798-022-09780-z

Yetkin, N., & Aküzüm, C. (2022). Investigation of the relationship between primary school 4th grade students' conceptions of learning and attitudes towards STEM education. *Journal of the Human and Social Science Researches, 11*(1), *744-769.*

Zigler, E., & Muenchow, S. (1992). *Head start: The inside story of America's most successful educational experiment.* Basic Books.

Zulela, M. S., & Rachmadtullah, R. (2019). Constructivism approach in learning to write narrative at elementary school. *Advances in Social Science, Education and Humanities Research*, *178*, 287-290. https://doi.org/10.2991/icoie18.2019.64

Xu, C., & Lastrapes, R. E. (2022). Impact of STEM sense of belonging on career interest: The role of STEM attitudes. *Journal of Career Development*, *49*(6), 1215-1229. https://doi/10.1177/08948453211033025