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Research Article

Hopes and goals of secondary school students towards STEM education and their pseudoscience beliefs

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In today's world, where science and technology are developing rapidly, raising science-literate individuals has gained importance in order to keep up with the requirements of the digital age. In line with this, STEM education, which is the integration of science, technology, engineering, and mathematics, has become the center of attention. However, an increase in the interest in science causes an increase in pseudo-scientific beliefs, which are far from being scientific. Therefore, this study investigated whether secondary school students' hopes and goals towards STEM education and pseudoscience beliefs differ by gender, grade level, and parental education level. In addition, the correlation between the students' pseudo-science beliefs and their hopes and goals towards STEM education was also investigated. A total of 351 secondary school students participated in this study. The "Hopes and Goals Survey" and "Pseudoscience Belief Scale" were used for data collection. As a result of the study, it was found that the hopes and goals of students towards STEM statistically differ by gender, in favor of female students, by grade level, in favor of lower-grade students, and maternal education level, in favor of students whose mothers had a bachelor's degree or higher. However, despite the higher hopes and goals towards STEM education scores in students with university graduate fathers than the others, the difference was not statistically significant. It's also revealed that pseudoscience beliefs of the secondary school students differ significantly by gender, in favor of female students, and by grade level, in favor of upper-grade students. While it is noteworthy that the pseudoscience beliefs of the students with primary school graduate fathers were higher than the others, the difference was not statistically significant. Moreover, the pseudoscience beliefs of secondary school students did not differ significantly in terms of maternal education level. A positive and significant correlation was found between the students' pseudo-medical claims and their hopes and goals towards STEM education. Moreover, there was a positive and significant correlation between the students' pseudo-medical claims and the learning in school hope. On the other hand, there was a negative and significant correlation between the learning in school hope and pseudo-predictive claims of the students. In addition, there was a negative and significant correlation between the job satisfaction hope and pseudo-predictive claims of the students.

Keywords: Pseudoscience; Hopes and goals; STEM

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1. Introduction

Innovations and rapid changes in science and technology leads to a change in the qualifications required for the workforce, which in turn, gradually increases the importance of raising individuals who are able to think, produce, and question. For this reason, it is essential for education programs and approaches to address 21st-century innovations. The 21st-century skills, such as creativity, critical thinking, collaboration, and problem solving, have become very important and have been expressed as a kind of "universal literacy" to keep up with the 21st-century (Akgündüz et al., 2015). Today, 21st-century countries have set their main goal as raising students as qualified individuals who have moved away from individualism, have adopted world citizenship, and have the requirements on the way to world citizenship (Kaya, 2015). In this context, the United States and many European countries aim to bring each student to the level of "science literate" individuals with a scientific point of view, instead of laying too much of a burden on students through excessive scientific knowledge in science education (Çakıcı, 2009). In Turkey, the Ministry of National Education made a series of arrangements and updates at various times and determined the purpose of the science curriculum as "training all students as science and technology literate regardless of individual differences". (Karatay et al., 2013). Due to the increasing necessity of science literacy, educators also use different approaches in the curriculum, and one of these approaches is the STEM education (Karakaya et al., 2018). STEM is the abbreviation of the initials of the terms Science, Technology, Engineering, and Mathematics (National Science and Technology Council, 2013). STEM is an educational approach that focuses on integrating science, technology, engineering, and mathematics knowledge and skills in curricula, aiming to provide students with the ability to cooperate, communicate, think critically, be creative, productive, inquisitive, and create solutions to problems (Buyruk & Korkmaz, 2016). The STEM approach, which is the abbreviation of the concepts of Science, Technology, Engineering, and Mathematics, is called the FeTeMM approach in Turkish (Aytekin, 2018).

Today, people's belief in science is on the rise thanks to the idea that scientific knowledge is reliable. In today's world, where science and technology are appreciated to a great extent, media and mass media allow help scientific research and discourses to reach larger masses (Turgut, 2009). Therefore, it would be inevitable for the so-called scientific beliefs to have a place in society to a great extent. Research results confirm that there is a tendency to accept pseudo-scientific discourses among science students (Walker et al., 2002). Beyerstein (1996) defined pseudoscience as a field that has the appearance of being scientific, copies scientific processes and terms, but does not meet the necessary scientific conditions in order to use the power of science.

The increase in the perceived value of science has led to the emergence of pseudo-scientific fields, and accordingly, the debate on how to separate science from pseudoscience has emerged (Arık & Akçay, 2018). It is known that the distinction between pseudoscience and science is not easy since a definitive set of acceptable criteria that can be used under all circumstances has not been established yet in order to make a clear distinction between the two (Turgut, 2011). This distinction problem is still being investigated by different philosophers of science (Afonso & Gilbert, 2010). The persistence of uncertainty over this distinction issue means that there is no agreed process on how to separate science from pseudoscience (Beyerstein, 1996). Allchin (2004) states that "Many fields that are considered pseudoscience today were accepted as science yesterday" on the difficulty of this distinction. As an example of this phenomenon, acupuncture, which was previously considered a pseudoscience, is now accepted a scientific method (Afonso & Gilbert, 2010). Since it will support scientific literacy, it is essential to include discussions on the distinction between science and pseudoscience, using current theoretical explanations, in science courses (Çetinkaya et al., 2015).

It is necessary to raise generations capable of interpreting scientific changes and developments, distinguishing between science and pseudoscience, knowing the value of scientific knowledge, and adopting scientific literacy (Turgut et al., 2016). Since science literate people who understand the nature of science would look at the data they have obtained with skeptical eyes, they would not believe them without questioning them and thinking about the outcomes (Canan, 2019). It is also stated in innovative science education programs that teaching the nature of science has a significant impact on raising science literate individuals (Kutluca & Aydın, 2016).

Turgut (2009) has initiated a discussion on whether students' attitudes towards science can be improved and stated that the distinction between science and pseudoscience should be addressed in the curricula and science textbooks. Although there are activities that would make students comprehend the nature of science in the science and technology curriculum in Turkey, there are no activities presented to secondary school students regarding the distinction between science and pseudo-science (Çetinkaya, 2012). It was emphasized that the inclusion of easy and understandable examples of the science and pseudoscience distinction in the science curriculum, such as activities to explore the distinction between astrology and astronomy, may be interesting to students, and improve their critical thinking skills, which in turn increase their inquisitiveness (Turgut, 2009).

1.1. Hopes and Goals

The dictionary definition of hope is the "desire accompanied by expectation of or belief in fulfillment" (Cambridge University Press., n.d). In the goal setting, Snyder et al. (1991) stated that hope has two main interrelated factors. First, they stated that hope is fueled by the perception of successful agency regarding goals, which in turn creates a sense of successful determination in achieving past, present, and future goals. Second, it is assumed that hope is influenced by the perceived availability of successful pathways to goals. The pathways component refers to the feeling of being able to make successful plans in order to be able to achieve goals. More officially, hope was defined as a reciprocally derived cognitive set based on (a) agency (goal-oriented setting) and (b) pathways (planning the ways to achieve goals). Due to the underlying sense of agency and ways of achieving goals, in general, people with higher hopes should have more goals in various areas of their lives and choose and achieve more difficult goals than the others. Regardless of the level of hope, one must face the associated barriers to choose, evaluate, and move towards a goal. Until some extreme target intervention, individuals with a high-level hope maintain the agency behavior and pathways behavior. On the contrary, people with lower hopes should be more likely to reduce their agency and pathways in the face of increasingly steep goal barriers. Moreover, as they noted, people with a higher hope should evaluate their goals and intervening obstacles with more positive, challenge-like assessments, compared to a lower level of hope. Snyder et al. (1991, p.570) concluded that "the predominant view is that increased hopefulness is generally associated with positive outcomes".

Various hope-related words are used in the literature, such as expectation, aspiration, and optimism (Douglas & Strobel, 2015). The dictionary definition of optimism is "the tendency to be hopeful and to emphasize or think of the good part in a situation rather than the bad part, or the feeling that in the future good things are more likely to happen than bad things" (Cambridge University Press., n.d). Despite a conceptual similarity between optimism and hope, there are remarkable differences between the two. Merely, an optimist somehow believes that his/her future will be successful and fulfilling, either by luck, by the actions of others, or by his/her own actions. A hopeful individual especially believes in his/her own capacity to secure a successful and fulfilling future (Alarcon et al., 2013). Contrary to optimism theory, expectations based on personal efficacy are seen as the main determinants of behavior in the context of self-efficacy theory. An outcome expectancy can be considered a belief that a specific behavior leads to a specific outcome (Bandura, 1977). Efficacy and outcome expectations are similar to the agency and pathway components of the hope model (Snyder et al., 1991). According to Maddux et al. (1982), self-efficacy theory argues that self-efficacy expectancy, a belief about one's ability to successfully perform a behavior, is independent of outcome expectancy, a belief about the likelihood of the behavior leading to a specific outcome. The hypothesis that self-efficacy and outcome expectation are independent of each other and have independent effects on behavior change was tested. The results revealed that an increase in outcome expectation increases the intention to perform the behavior. An increase in self-efficacy expectations results in a non-significant increase in intentions. In addition, change in outcome expectation affects self-efficacy expectations. Subjects who believe that relatively difficult behaviors likely lead to positive outcomes had greater confidence in their ability to perform these behaviors than those who perceived a relatively weak relationship between the behaviors and outcomes. It has been suggested that the degree of risk involved in attempting to perform a behavior correctly can determine the extent to which self-efficacy expectancy affects behavioral decisions.

Although the hope is an important phenomenon in education (Douglas & Strobel, 2015), hope is eroded through numerous influences. Therefore, it is important to determine which variables affect the hopes and goals of the students. In a study that compared hope levels among students from different backgrounds, and investigated the relationship of hope with other factors, Chang and Banks (2007) found that hope was associated with problem-solving, impulse control, life satisfaction, and affection. They determine similar levels of hope and associations across groups and suggest that early life challenges help to develop hope in minorities. According to theories of child development and career development, "It is never too early". The years passed are of great importance in the formation of ideas and perceptions of children about both themselves and the world around them. Through the encouragement and guidance of adults, children can develop skills and attitudes that strengthen their knowledge and understanding of the world. They would develop the ability to evaluate alternatives, set goals, plan action to achieve goals, engage in self-assessment, and initiate change as appropriate. They help them become active participants in their own lives, rather than passively reacting to the events and transitions encountered through life. Intentionally incorporating the concepts of career awareness, exploration, and planning into children's early experiences in making decisions about themselves and the world would encourage them to adopt the career planning process as a "habit of the mind." It's never too early to help children to develop self-actualization that stems from personal satisfaction through a task well done (Magnuson, & Starr, 2000).

1.2. Pseudoscience Beliefs

> “If we teach only the findings and products of science —no matter how useful and even inspiring they may be— without communicating its critical method, how can the average person possibly distinguish science from pseudo-science?” (Sagan, 1996, p.21).

An important feature of scientific literacy is the ability to make credible judgments about the claims of people, especially scientists. Scientific literacy is important in modern society as people face debates and problems of scientific and technological nature. The literature on science education suggests that both the public and students often have narrow, stereotypical views about scientists and science (Coll et al., 2009).

Although an understanding of the nature of science is essential for scientific literacy, there is considerable evidence that school and university students are indifferent about this fact. It is argued that the lack of knowledge about the nature of science is due to the shortcomings of formal science education, as well as due to the adoption of the principles of pseudoscience, a set of beliefs that have broad cultural relevance in the general population (Afonso & Gilbert, 2010).

Pseudoscience is defined as "a system of thought or a theory formed on non-scientific grounds" in the dictionary (Cambridge University Press., n.d). Despite the masquerade of science, pseudoscience is not a science. However, not all non-scientific issues are pseudoscience. For instance, it is bad science but not pseudoscience for a lab worker in a chemistry lab to accidentally contaminate a sample, have a false pipette reading and report an incorrect result. Assuming this lab worker is behaving by scientific standards while working in a chemistry lab, then what this worker does is just poor science. Poorly conducted science is still science (Monton, 2013).

Gardner (2001, p.1) stated that "I am aware of the difficulties involving what philosophers of science call the 'demarcation problem' - the task of formulating sharp criteria for distinguishing good science from poor science. Clearly, such criteria are not precise. Pseudo-science is a fuzzy word that refers to a vague portion of a continuum on which there are no sharp boundaries." Gardner divides this continuum into four categories. The first one is the "beliefs considered irrational by all scientists", such as the hollow-world belief, which argues that the world is a hollow sphere, and we live inside this sphere. The second is "slightly less weird claims" like homeopathy and Scientology. Third, "controversial claims" such as the belief that God played a role in evolution and claims about the ability to extract unlimited energy from the vacuum of space. Gardner's fourth category is "open conjectures by scientists", such as the speculation about other universes and panspermia - the view that life arose elsewhere and came to Earth later. Consequently, evidence plays a key role in proclaiming something pseudo-scientific. For example, people used to believe the earth was flat, given the evidence they had at the time. However, the hypothesis that the earth is flat is now pseudo-scientific. In addition, it can also be stated that pseudoscience depends on the era and culture. An individual can act pseudo-scientifically under social pressure, despite evidence on the subject matter (Monton, 2013).

Martin (1994) argues that pseudoscience and paranormal studies are important but neglected aspects of science education. Given the widespread acceptance of pseudoscience and paranormal beliefs, he suggested that science educators should address the problem seriously, and that science students should be taught to critically evaluate the claims of pseudoscience and paranormal beliefs. Introducing pseudo-scientific and paranormal claims into science courses, as well as subjecting these claims to testing may warn students against the dangers of pseudo-scientific medical procedures. It can also serve to motivate students to receive science training. Students are often fascinated by claims about paranormal activities. While some science teachers would like to dismiss this, many students are more interested in mysteries of the Bermuda Triangle, ESP, and ghosts than in Archimedes' Principle, the law of buoyancy force, and the physiology of frogs. As a result, it can be used to test paranormal claims, motivate students, and cheer up a generally indifferent classroom. For these reasons, a science teacher should not feel guilty for using these motivational tools to teach students to question the pseudo-scientific and paranormal claims from a critical perspective. It is the responsibility of science educators to utilize pedagogy knowledge to help students distinguish between scientific and pseudoscientific claims, while honoring the goals of science education (Mugaloglu, 2014).

The STEM education aims to help students to learn how to apply the basic content and practices of STEM disciplines to situations they encounter in life (Bybee, 2013). This study investigated whether the hopes and goals towards STEM education and pseudoscience beliefs of secondary school students differ by gender, grade level, and parental education level. In addition, the correlation between the students' pseudo-science beliefs and their hopes and goals towards STEM education was also investigated.

The research questions are as follows:

RQ 1) Do hopes and goals of secondary school students towards STEM education differ significantly by gender?

RQ 2) Do pseudoscience beliefs of secondary school students differ significantly by gender?

RQ 3) Do hopes and goals of secondary school students towards STEM education differ significantly by grade?

RQ 4) Do pseudoscience beliefs of secondary school students differ significantly by grade?

RQ 5) Do hopes and goals of secondary school students towards STEM education differ significantly by maternal education level?

RQ 6) Do pseudoscience beliefs of secondary school students differ significantly by maternal education level?

RQ 7) Do hopes and goals of secondary school students towards STEM education differ significantly by paternal education level?

RQ 8) Do pseudoscience beliefs of secondary school students differ significantly by paternal education level?

RQ 9) Is there a correlation between the hopes and goals of the secondary school students towards STEM education and their pseudoscience beliefs?

2. Methods

2.1. Research Design and Sample

As one of the quantitative research methods, the survey method was used in this study. The study population consisted of secondary school students in the city center of a province in the Marmara region of Turkey. As one of the non-random sampling methods, the stratified purposeful sampling method was used. The study sample consisted of a total of 351 students: 6th graders (n=97), 7th graders (n=116), and 8th graders (n=138) studying at a secondary school in the Marmara region of Turkey in the first semester of the 2019-2020 academic year.

2.2. Data Collection Tools

All the study data were collected using the face-to-face technique in a classroom environment. Students were given sufficient time to respond to the relevant scales.

2.2.1. Hopes and Goals Survey

The "Hopes and Goals Survey", developed by Douglas and Strobel (2015) and adapted to Turkish by Kurt (2019), measures the level of hope of elementary school students, of diverse backgrounds, and their interests in science, technology, engineering, and mathematics (STEM) fields and career opinions in these fields. It's a 5-point Likert-type scale consisting of 20 items and five sub-scales: "learning in school hope (4 items)", "job satisfaction hope (5 items)", "attitudes towards science (4 items)", "attitudes towards engineering (4 items)", "attitudes towards mathematics (3 items)". In the present study, the Cronbach's alpha reliability coefficient of this 20-item scale was found to be .875, and the Cronbach's alpha values for the sub-scales were calculated as .65, .769, .840, .922, and .847, respectively. The minimum and maximum scores on this scale range from 3 to 25. Douglas and Strobel (2015) found that the "Hopes and Goals Survey" is a five-factor model with internal consistency ranging from .609 to .904, and overall reliability of .844.

2.2.2. Pseudoscience Belief Scale

The "Pseudoscience Belief Scale" was developed by Çetinkaya and Taşar (2018) for evaluating the pseudoscience beliefs of secondary school students. It's a 5-point Likert-type scale consisting of 21 items and three sub-scales: "pseudo-physical claims" (9 items), "pseudo-predictive claims" (7 items), and "pseudo-medical claims" (5 items). In the present study, the Cronbach's alpha reliability coefficient of this 21-item scale was found to be .910, and the Cronbach's alpha values for the sub-scales were calculated as .882, .815, and .755, respectively. The minimum and maximum scores obtained on this scale range from 5 to 45. Çetinkaya and Taşar (2018) determined the Cronbach's alpha (α) reliability coefficient of this scale as .84, and the McDonald's omega (ω) reliability coefficient as .91. As for the sub-scales, McDonald' Omega (ω) reliability coefficient was found as .85 for the pseudo-physical claims sub-scale, .81 for the pseudo-predictive claims sub-scale, and .71 for the pseudo-medical claims sub-scale.

2.3. Data Analysis

In this section, independent samples t-test analysis results were presented regarding the hopes and goals of the students towards STEM education and their pseudoscience beliefs by gender. One-way analysis of variance (ANOVA) was performed to determine whether the hopes and goals scores towards STEM education and pseudoscience beliefs of the students statistically differ according to grade levels, and maternal and paternal education levels. In addition, a simple linear correlation procedure was carried out to reveal whether there is a correlation between the hopes and goals of the secondary school students towards STEM education and their pseudoscience beliefs.

3. Results

The study data, collected using the "Hopes and Goals Survey" and "Pseudoscience Belief Scale", were analyzed in terms of some variables, including gender, grade level, and parental education level. The descriptive analysis results of the "Hopes and Goals Survey" and its sub-scales are shown in Table 1.

Table 1
Descriptive statistics of the "Hopes and Goals Survey"

Sub-scale	*N*	*Min*	*Max*	*Mean*	*Median*	*Mod*	*Skewness*	*Kurtosis*
Learning in school hope	351	4	20	16.38	17	19	−1.009	0.797
Job satisfaction hope	351	5	25	20.57	21	25	−0.794	1.125
Attitudes towards science	351	4	20	14.10	14	20	−0.356	−0.502
Attitudes towards engineering	351	4	20	11.89	12	12	0.036	−0.693
Attitudes towards mathematics	351	3	15	10.60	11	15	−0.507	−0.502
Total	351	20	100	73.53	75	78	−0.343	−0.166

In Table 1, the descriptive statistics indicated that the average scores of the students' job satisfaction hope sub-dimension ($\bar{X} = 20.57$) and learning in school hope ($\bar{X} = 16.38$) were higher than the average value of the scale ($\bar{X} = 15.20$) and other sub-dimensions. Table 2 shows the descriptive analysis results of the pseudoscience belief scale and its sub-scales.

Table 2
Descriptive statistics of the "Pseudoscience Belief Scale"

Sub-scale	*N*	*Min*	*Max*	*Mean*	*Median*	*Mod*	*Skewness*	*Kurtosis*
Pseudo-physical claims	351	9	45	19.26	17	9	0.948	0.424
Pseudo-predictive claims	351	7	35	14.83	14	7	0.878	0.667
Pseudo-medical claims	351	5	25	13.29	13	13	0.090	−0.500
Total	351	21	105	47.38	46	41	0.722	0.585

Table 2 shows that the average score of the students' pseudo-physical claims sub-scale ($\bar{X} = 19.26$) was higher than the overall score average of the pseudoscience belief scale ($\bar{X} = 16.36$).

Looking at the descriptive statistical data presented in Table 1 and Table 2, it is seen that the skewness and kurtosis values are between -1.5 and +1.5. Skewness and kurtosis values in the range of -1.5 to +1.5 indicate a normal distribution (Tabachnick & Fidell, 2013). As a result, the data obtained with the scales used in this study had a normal distribution.

In this section, independent samples t-test analysis results were presented regarding the hopes and goals of the students towards STEM education and their pseudoscience beliefs by gender. One-way analysis of variance (ANOVA) was performed to determine whether the hopes and goals scores towards STEM education and pseudoscience beliefs of the students statistically differ according to grade levels, and maternal and paternal education levels. In addition, simple linear correlation results were provided for the correlation between the hopes and goals of the secondary school students towards STEM education and their pseudoscience beliefs.

In order to determine whether the hopes and goals of the students towards STEM education differ by gender, independent samples t-test analysis was performed. The results of this analysis are presented in Table 3.

According to Table 3, the hopes and goals of female students towards STEM education ($\bar{X} = 75.41$) were higher than male students ($\bar{X} = 71.64$), and there was a statistically significant difference between the mean total scores of the male and female students, in favor of female students [$t(349) = -2.85, p < .05$].

Table 3
Independent samples t-test results for the hopes and goals towards STEM education by gender

Sub-scale	*Gender*	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Learning in school hope	Male	175	15.49	3.25	349	-5.71	.000*
	Female	176	17.26	2.51			
Job satisfaction hope	Male	175	20.19	3.57	349	-2.09	.037*
	Female	176	20.94	3.20			
Attitudes towards science	Male	175	13.63	4.34	349	-2.18	.030*
	Female	176	14.57	3.78			
Attitudes towards engineering	Male	175	12.19	4.65	349	1.27	.204
	Female	176	11.59	4.23			
Attitudes towards mathematics	Male	175	10.14	3.72	349	-2.51	.013*
	Female	176	11.05	3.02			
Total	Male	175	71.64	13.87	349	-2.85	.005*
	Female	176	75.41	10.81			

**Note.* $p < .05$

Looking at the sub-scales of the hopes and goals survey towards STEM education by gender, all sub-scales of the survey were found to differ significantly by gender, except for the attitudes towards the engineering sub-scale. Attitudes of the students towards the engineering sub-scale did not differ significantly by gender [$t(349) = 1.27, p > .05$]. In other words, there was no statistically significant difference between male and female students in terms of their attitudes towards engineering. As shown in Table 3, there was a statistically significant difference between male and female students in terms of the learning in school hope, in favor of females [$t(349) = -5.71$, $p < .05$]. Similarly, there was a statistically significant difference between male and female students in terms of the job satisfaction hope, in favor of females [$t(349) = -2.09$, $p < .05$]. Moreover, there was a statistically significant difference between male and female students in terms of their attitudes towards science, in favor of females [$t(349) = -2.18$, $p < .05$]. In addition, there was a statistically significant difference between male and female students in terms of their attitudes towards mathematics, in favor of females [$t(349) = -2.51$, $p < .05$].

Table 4 shows the independent samples t-test results of the pseudoscience beliefs of the secondary school students in terms of gender.

Table 4
Independent samples t-test results for the pseudoscience belief by gender

Sub-scale	*Gender*	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Pseudo-physical claims	Male	175	18.65	8.04	349	-1.36	.174
	Female	176	19.87	8.69			
Pseudo-predictive claims	Male	175	14.29	5.94	349	-1.70	.091
	Female	176	15.36	5.94			
Pseudo-medical claims	Male	175	12.29	4.70	349	-4.03	.000*
	Female	176	14.28	4.53			
Total	Male	175	45.23	15.91	349	-2.51	.013*
	Female	176	49.51	16.06			

**Note.* $p < .05$

According to Table 4, the total pseudoscience beliefs score of the female students ($\bar{X} = 49.51$) was higher than males ($\bar{X} = 45.23$) and there was a statistically significant difference between the mean scores of male and female students, in favor of female students [$t(349) = -2.51$, $p < .05$]. Looking at the sub-scales of the pseudoscience belief scale, a significant mean difference was only found in the pseudo-medical claims sub-scale by gender, in favor of female students [$t(349) = -4.03$, $p < .05$].

The descriptive statistics for the hopes and goals towards STEM education by grade are shown in Table 5.

Table 5
Descriptive statistics for the hopes and goals towards STEM education by grade

Sub-scale	*Grade Level*	*N*	$\overline{X}$	*SD*
Learning in school hope	6	97	16.19	3.04
	7	116	16.54	3.17
	8	138	16.38	2.92
	Total	351	16.38	3.03
Job satisfaction hope	6	97	20.72	3.89
	7	116	21.00	2.85
	8	138	20.09	3.45
	Total	351	20.57	3.41
Attitudes towards science	6	97	15.43	3.95
	7	116	14.22	3.48
	8	138	13.06	4.39
	Total	351	14.10	4.09
	6	97	11.97	4.67
Attitudes towards engineering	7	116	12.28	4.02
	8	138	11.50	4.63
	Total	351	11.87	4.45
Attitudes towards mathematics	6	97	10.85	3.61
	7	116	11.29	3.03
	8	138	9.84	3.46
	Total	351	10.60	3.42
Total	6	97	75.15	12.66
	7	116	75.34	10.94
	8	138	70.87	13.35
	Total	351	73.53	12.56

As shown in the descriptive statistics presented in Table 5, 7th−grade secondary school students were found to have higher total and sub-scale scores in the hopes and goals towards STEM education survey, except the attitudes towards science sub-scale.

As can be seen from Table 6, One-way ANOVA was performed to determine whether the hopes and goals scores of the students towards STEM education differ significantly according to their grade levels.

Table 6 shows that the hopes and goals of the students towards STEM education differ significantly by their grade level, according to the scores taken in this survey $[F(2-348) = 5.22,\ p < .05]$. Considering the total scores in the hopes and goals survey towards STEM education, there was a statistically significant difference between the mean scores of the 6th and 8th−grade students, in favor of 6th−grade students, and between the mean scores of the 7th and 8th−grade students, in favor of 7th−grade students.

Looking at the sub-scales of the hopes and goals towards STEM education survey, according to the grade level, there was a statistically significant difference between the mean scores of the 6th and 8th−grade students in terms of their attitudes towards science, in favor of 6th−graders $[F(2-348) = 10.16,\ p < .05]$. Similarly, there was a statistically significant difference between 7th and 8th−grade students in terms of their attitudes towards mathematics, in favor of 7th−graders $[F(2-348) = 6.25,\ p < .05]$.

Table 6

One-way ANOVA results for the hopes and goals towards STEM education by grade

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Learning in school hope	Between groups	6.75	2	3.38	.37	.69	-
	Within groups	3210.81	348	9.23			
	Total	3217.56	350				
Job satisfaction hope	Between groups	55.21	2	27.60	2.39	.09	-
	Within groups	4013.06	348	11.53			
	Total	4068.27	350				
Attitudes towards science	Between groups	323.02	2	161.51	10.16	.00*	6>8
	Within groups	5531.02	348	15.89			
	Total	5854.04	350				
Attitudes towards engineering	Between groups	38.89	2	19.44	.98	.38	-
	Within groups	6888.67	348	19.79			
	Total	6927.56	350				
Attitudes towards mathematics	Between groups	141.43	2	70.71	6.25	.00*	7>8
	Within groups	3940.82	348	11.32			
	Total	4082.24	350				
Total	Between groups	1608.62	2	804.31	5.22	.01*	6>8
	Within groups	53581.06	348	153.97			7>8
	Total	55189.68	350				

**Note.* $p < .05$

Table 7 shows the descriptive statistics for the pseudoscience beliefs of the secondary school students by grade.

Table 7

Descriptive statistics for the pseudoscience beliefs of the secondary school students in terms of their grade

Sub-scale	*Grade Level*	*N*	$\overline{X}$	*SD*
Pseudo-physical claims	6	97	15.87	6.38
	7	116	19.31	7.71
	8	138	21.61	9.35
	Total	351	19.26	8.38
Pseudo-predictive claims	6	97	14.26	5.40
	7	116	15.24	5.66
	8	138	14.88	6.55
	Total	351	14.83	5.96
Pseudo-medical claims	6	97	12.02	4.17
	7	116	13.83	4.46
	8	138	13.72	5.14
	Total	351	13.29	4.72
	6	97	42.14	13.04
Total	7	116	48.38	15.08
	8	138	50.21	18.01
	Total	351	47.38	16.10

As shown in Table 7, it was found that the pseudo-predictive claims and pseudo-medical claims sub-scale scores of the 7th graders were higher than the others, while the scores of the 8th-graders in pseudo-physical claims and total pseudoscience beliefs were higher than the others.

One-way ANOVA was performed to determine whether the scores of secondary school students in the pseudoscience belief scale differ significantly according to their grade level, and the analysis results were presented in Table 8.

Table 8
One-way ANOVA results for the pseudoscience beliefs by grade levels of the students

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Pseudo-physical claims	Between groups	1878.36	2	939.18	14.38	.00*	7>6
	Within groups	22721.36	348	65.29			8>6
	Total	24509.72	350				
Pseudo-predictive claims	Between groups	51.74	2	25.87	.73	.48	-
	Within groups	12366.59	348	35.54			
	Total	12418.33	350				
Pseudo-medical claims	Between groups	215.54	2	107.77	4.95	.01*	7>6
	Within groups	7570.95	348	21.76			8>6
	Total	7786.49	350				
Total	Between groups	3880.42	2	1940.21	7.77	.00*	7>6
	Within groups	86894.78	348	249.70			8>6
	Total	90775.20	350				

**Note.* $p < .05$

Looking at the total scores of the secondary school students in the pseudoscience belief scale and its sub-scales, as shown in Table 8, there was a statistically significant difference between the mean scores of the 6th and 7th graders, in favor of 7th graders, and between the mean scores of the 6th and 8th graders, in favor of 8th graders in terms of pseudo-physical claims sub-scale $[F(2-348) = 14.38, p < .05]$, pseudo-medical claims sub-scale $[F(2-348) = 4.95, p < .05]$, and in terms of the total scores taken in this scale $[F(2-348) = 7.77, p < .05]$.

Table 9 shows the descriptive statistics for the hopes and goals towards STEM education in terms of maternal education level.

Table 9
Descriptive statistics for the hopes and goals towards STEM education by maternal education level

Sub-scale	*Mother's educational level*	*N*	$\overline{X}$	*SD*
Learning in school hope	Primary school	120	16.03	3.12
	Secondary school	111	15.99	3.41
	High school	76	16.61	2.42
	University	44	17.94	2.16
	Total	351	16.38	3.03
Job satisfaction hope	Primary school	120	20.28	3.51
	Secondary school	111	20.59	3.55
	High school	76	20.49	3.18
	University	44	21.43	3.12
	Total	351	20.57	3.41
Attitudes towards science	Primary school	120	14.03	4.39
	Secondary school	111	13.94	3.76
	High school	76	13.72	4.19
	University	44	15.34	3.76
	Total	351	14.10	4.09
Attitudes towards engineering	Primary school	120	11.57	4.62
	Secondary school	111	12.18	4.39
	High school	76	11.32	4.37
	University	44	13.00	4.14
	Total	351	11.89	4.45
Attitudes towards mathematics	Primary school	120	10.35	3.56
	Secondary school	111	10.76	3.03
	High school	76	10.29	3.48

Table 9 continued

Sub-scale	*Mother's educational level*	*N*	$\overline{X}$	*SD*
	University	44	11.39	3.77
	Total	351	10.60	3.42
Total	Primary school	120	72.25	13.50
	Secondary school	111	73.47	11.84
	High school	76	72.42	12.09
	University	44	79.10	11.26
	Total	351	73.53	12.56

The descriptive statistics for the hopes and goals towards STEM education by maternal education level indicate that students with university graduate mothers had higher scores in the hopes and goals towards STEM education than the others (Table 9).

To determine whether the scores of secondary school students in the hopes and goals towards STEM education scale differ significantly according to maternal education level, one-way ANOVA was performed, as presented in Table 10.

Table 10

One-way ANOVA results for the hopes and goals towards STEM education by maternal education level

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Learning in school hope	Between groups	142.15	3	47.38	5.35	.00*	U>PS
	Within groups	3075.41	347	8.86			U>SS
	Total	3217.56	350				
Job satisfaction hope	Between groups	43.40	3	14.47	1.25	.29	-
	Within groups	4024.87	347	11.60			
	Total	4068.27	350				
Attitudes towards science	Between groups	81.79	3	27.27	1.64	.18	-
	Within groups	5772.24	347	16.63			
	Total	5854.04	350				
Attitudes towards engineering	Between groups	101.19	3	33.73	1.72	.16	-
	Within groups	6826.37	347	19.67			
	Total	6927.56	350				
Attitudes towards mathematics	Between groups	45.03	3	15.01	1.29	.28	-
	Within groups	4037.22	347	11.64			
	Total	4082.25	350				
Total	Between groups	1652.85	3	550.95	3.57	.01*	U>PS
	Within groups	53536.82	347	154.29			U>HS
	Total	55189.68	350				

**Note.* $p < .05$; U: University; PS: Primary school; SS: Secondary school; HS: High school

As shown in Table 10, there was a statistically significant difference between the mean hopes and goals towards STEM education total scores of the secondary school students according to their maternal education level [$F(3-347) = 3.57, p < .05$]. According to the Tukey test results, there was a significant difference between the students with university graduate mothers and students with primary school graduate mothers, and between the students with university graduate mothers and students with high school graduate mothers, in favor of the students with university-graduate mothers, in terms of total scores in the hopes and goals towards STEM education survey. In addition, it was noticed that students' learning in school hope differs significantly according to maternal education level. A significant difference was found between the students with university graduate mothers and students with primary school graduate mothers, and between the students with university graduate mothers and students with secondary school graduate mothers, in favor of the students with university-graduate mothers, in terms of the learning in school hope sub-scale scores of the students.

Descriptive statistics for the pseudoscience beliefs of the secondary school students in terms of maternal education level are shown in Table 11.

Table 11
Descriptive statistics for the hopes and goals towards STEM education by maternal education level

Sub-scale	*Mother's educational level*	*N*	$\overline{X}$	*SD*
Pseudo-physical claims	Primary school	120	18.32	7.49
	Secondary school	111	19.02	8.97
	High school	76	20.30	9.33
	University	44	20.64	7.28
	Total	351	19.26	8.38
Pseudo-predictive claims	Primary school	120	14.30	5.78
	Secondary school	111	15.68	6.65
	High school	76	15.01	5.88
	University	44	13.80	4.39
	Total	351	14.83	5.96
Pseudo-medical claims	Primary school	120	13.16	4.62
	Secondary school	111	12.72	4.86
	High school	76	14.16	4.80
	University	44	13.55	4.38
	Total	351	13.29	4.72
Total	Primary school	120	45.79	15.12
	Secondary school	111	47.42	18.29
	High school	76	49.48	15.89
	University	44	47.98	12.94
	Total	351	47.38	16.10

Looking at the pseudoscience beliefs total scores of the students shown in Table 11, it is seen that students with high-school graduate mothers had higher pseudoscience beliefs than the others. Considering the sub-scales of the pseudoscience belief scale, it was found that the "pseudo-physical claims" sub-scale score was higher in students with university graduate mothers, the "pseudo-predictive claims" sub-scale score was higher in students with secondary-school graduate mothers, and the "pseudo-medical claims" sub-scale score was higher in students with high-school graduate mothers.

Table 12 shows the one-way ANOVA results for the pseudoscience beliefs of the secondary school students in terms of maternal education level.

Table 12
One-way ANOVA results for the pseudoscience beliefs of the secondary school students in terms of maternal education level

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Pseudo-physical claims	Between groups	277.24	3	92.41	1.32	.27	-
	Within groups	24322.49	347	70.09			
	Total	24599.73	350				
Pseudo-predictive claims	Between groups	163.92	3	54.64	1.55	.20	-
	Within groups	12254.41	347	35.32			
	Total	12418.33	350				
Pseudo-medical claims	Between groups	98.92	3	32.97	1.49	.21	-
	Within groups	7687.57	347	22.15			
	Total	7786.49	350				
Total	Between groups	654.60	3	218.20	.84	.47	-
	Within groups	90120.60	347	259.71			
	Total	90775.20	350				

Table 12 shows that pseudoscience beliefs of secondary school students did not differ significantly in terms of maternal education level (p >.05).

Descriptive statistics for the hopes and goals towards STEM education by paternal education level are shown in Table 13.

Table 13
Descriptive statistics for the hopes and goals towards STEM education by paternal education level

Sub-scale	*Father's educational level*	*N*	$\overline{X}$	*SD*
Learning in school hope	Primary school	84	16.66	3.06
	Secondary school	104	15.99	3.22
	High school	113	16.21	2.87
	University	50	17.12	2.84
	Total	351	16.38	3.03
Job satisfaction hope	Primary school	84	20.58	3.19
	Secondary school	104	20.47	3.57
	High school	113	20.45	3.36
	University	50	21.00	3.59
	Total	351	20.57	3.41
Attitudes towards science	Primary school	84	14.19	4.01
	Secondary school	104	13.62	4.23
	High school	113	14.00	4.22
	University	50	15.18	3.50
	Total	351	14.10	4.09
Attitudes towards engineering	Primary school	84	11.58	4.41
	Secondary school	104	11.74	4.41
	High school	113	12.21	4.51
	University	50	11.96	4.54
	Total	351	11.89	4.45
Attitudes towards mathematics	Primary school	84	10.99	3.12
	Secondary school	104	10.52	3.51
	High school	113	10.21	3.34
	University	50	10.98	3.83
	Total	351	10.60	3.42
Total	Primary school	84	74.00	12.02
	Secondary school	104	72.33	13.03
	High school	113	73.09	12.47
	University	50	76.24	12.57
	Total	351	73.53	12.56

The descriptive statistics for the hopes and goals towards STEM education by paternal education level show that students with university graduate fathers had higher scores in the hopes and goals towards STEM education than the others, except for the attitudes towards engineering and attitudes towards mathematics sub-scales (Table 13).

Table 14 shows the one-way ANOVA results for the hopes and goals towards STEM education in terms of paternal education level. In Table 14, one-way ANOVA results showed that the hopes and goals of the secondary school students towards STEM education did not differ significantly according to paternal education level ($p > .05$).

Table 14
One-way ANOVA results for the hopes and goals towards STEM education by paternal education level

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Learning in school hope	Between groups	53.92	3	17.98	1.97	.12	-
	Within groups	3163.63	347	9.12			
	Total	3217.56	350				
Job satisfaction hope	Between groups	11.95	3	3.98	.34	.80	-
	Within groups	4056.32	347	11.69			
	Total	4068.27	350				
Attitudes towards science	Between groups	84.07	3	28.02	1.69	.17	-
	Within groups	5769.97	347	16.63			
	Total	5854.04	350				
Attitudes towards engineering	Between groups	22.19	3	7.40	.37	.77	-
	Within groups	6905.37	347	19.90			
	Total	6927.56	350				
Attitudes towards mathematics	Between groups	37.56	3	12.52	1.07	.36	-
	Within groups	4044.69	347	11.66			
	Total	4082.25	350				
Total	Between groups	559.61	3	186.54	1.19	.32	-
	Within groups	54630.07	347	157.44			
	Total	55189.68	350				

Descriptive statistics for the pseudoscience beliefs of the secondary school students in terms of paternal education level are shown in Table 15.

Table 15
Descriptive statistics for the pseudoscience beliefs of the secondary school students in terms of paternal education level

Sub-scale	*Father's educational level*	*N*	$\overline{X}$	*SD*
Pseudo-physical claims	Primary school	84	19.51	8.69
	Secondary school	104	19.93	8.77
	High school	113	17.94	7.26
	University	50	20.44	9.24
	Total	351	19.26	8.38
Pseudo-predictive claims	Primary school	84	15.55	6.72
	Secondary school	104	15.25	5.63
	High school	113	14.53	6.11
	University	50	13.42	4.63
	Total	351	14.83	5.96
Pseudo-medical claims	Primary school	84	14.02	5.15
	Secondary school	104	13.53	4.62
	High school	113	12.74	4.45
	University	50	12.78	4.68
	Total	351	13.29	4.72
Total	Primary school	84	49.08	17.57
	Secondary school	104	48.71	16.13
	High school	113	45.21	15.42
	University	50	46.64	14.81
	Total	351	47.38	16.10

Looking at the pseudoscience beliefs of the secondary school students by paternal education level shown in Table 15, it is seen that the students with primary school graduate fathers had higher scores in the pseudoscience beliefs than the others, except for the pseudo-physical claims sub-scale.

One-way ANOVA was performed to determine whether the scores of secondary school students in the pseudoscience belief scale differ significantly according to paternal education level, and the analysis results were presented in Table 16.

Table 16
One-way ANOVA results for the pseudoscience beliefs of the secondary school students in terms of paternal education level

Sub-scale	*Source of the Variance*	*Sum of Squares*	*df*	*Mean Rank*	*F*	*p*	*Tukey*
Pseudo-physical claims	Between groups	319.42	3	106.47	1.52	.21	-
	Within groups	24280.31	347	69.97			
	Total	24599.73	350				
Pseudo-predictive claims	Between groups	170.87	3	56.96	1.61	.19	-
	Within groups	12247.46	347	35.30			
	Total	12418.33	350				
Pseudo-medical claims	Between groups	97.46	3	32.49	1.47	.22	-
	Within groups	7689.04	347	22.16			
	Total	7786.49	350				
Total	Between groups	985.39	3	328.46	1.27	.29	-
	Within groups	89789.81	347	258.76			
	Total	90775.20	350				

Table 16 shows that pseudoscience beliefs of secondary school students did not differ significantly in terms of paternal education level ($p > .05$).

Table 17 shows the correlation between the students' pseudoscience beliefs and hopes and goals towards STEM education. A positive and significant correlation was found between pseudo-medical claims and the total score of the hopes and goals towards STEM education, according to the simple linear correlation procedure performed to reveal whether there is a correlation between the hopes and goals of the secondary school students towards STEM education and their pseudoscience beliefs ($r = 0.146, p < .01$). Moreover, there was a positive and significant correlation between the pseudo-medical claims and the learning in school hope of the students ($r = 0.140, p < .01$). On the other hand, there was a negative and significant correlation between the learning in school hope and pseudo-predictive claims of the students ($r = -0.126, p < .05$). In addition, there was a negative and significant correlation between the job satisfaction hope and pseudo-predictive claims of the students ($r = -0.127, p < .05$).

4. Discussion

Understanding perceptions of STEM dispositions of secondary school students is crucial in preparing the future STEM workforce and future citizens (Christensen & Knezek, 2017). In this study, secondary school students' hopes and goals towards STEM education and pseudoscience beliefs were investigated in terms of gender, grade level, and parental education level variables. Moreover, a correlation study was carried out between students' pseudoscience beliefs and their hopes and goals towards STEM education. The results of the current study showed that the hopes and goals of the secondary school students towards STEM education were above the average. On the other hand, it was found that the pseudoscience beliefs of the secondary school students were below the average.

Table 17
Correlation between the students' pseudoscience beliefs and hopes and goals towards STEM education

		HGSE-T	*PB-T*	*LSH*	*JSH*	*AS*	*AE*	*AM*	*P-Phy-C*	*P-Pre-C*	*P-Med-C*
HGSE-T	Pearson Correlation	1.000									
	Sig. (2-tailed)										
PB-T	Pearson Correlation	.053	1.000								
	Sig. (2-tailed)	.323									
LSH	Pearson Correlation	.676**	−.013	1.000							
	Sig. (2-tailed)	.000	.803								
JSH	Pearson Correlation	.729**	−.050	.605**	1.000						
	Sig. (2-tailed)	.000	.350	.000							
AS	Pearson Correlation	.669**	.058	.258**	.344**	1.000					
	Sig. (2-tailed)	.000	.282	.000	.000						
AE	Pearson Correlation	.649**	.089	.183**	.220**	.319**	1.000				
	Sig. (2-tailed)	.000	.096	.001	.000	.000					
AM	Pearson Correlation	.703**	.072	.444**	.445**	.275**	.319**	1.000			
	Sig. (2-tailed)	.000	.181	.000	.000	.000	.000				
P-Phy-C	Pearson Correlation	.058	.897**	−.015	−.045	.076	.096	.054	1.000		
	Sig. (2-tailed)	.282	.000	.774	.399	.154	.072	.314			
P-Pre-C	Pearson Correlation	−.054	.817**	−.126*	−.127*	−.019	.035	.019	.561**	1.000	
	Sig. (2-tailed)	.317	.000	.019	.017	.727	.518	.729	.000		
P-Med-C	Pearson Correlation	.146**	.789**	.140**	.070	.085	.089	.125*	.576**	.531**	1.000
	Sig. (2-tailed)	.006	.000	.008	.193	.113	.096	.019	.000	.000	

Note. *. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed); HGSE-T: Hopes and Goals toward STEM Education total; PB-T: Pseudoscience Beliefs total; LSH: Learning in school hope; JSH: Job satisfaction hope; AS: Attitudes towards science; AE: Attitudes towards engineering; AM: Attitudes towards mathematics; P-Phy-C: Pseudo-physical claims; P-Pre-C: Pseudo-predictive claims; P-Med-C: Pseudo-medical claims.

The study results showed that the hopes and goals of female students towards STEM education ($\bar{X} = 75.41$) were higher than male students ($\bar{X} = 71.64$), and there was a statistically significant difference between the mean total scores of the male and female students, in favor of female students. Considering the sub-scales of the hopes and goals towards STEM education survey by gender, the "learning in school hope", "job satisfaction hope", "attitudes towards science", and "attitudes towards mathematics" sub-scale scores of the students were found to differ significantly, in favor of females, except for the attitudes towards engineering sub-scale. This result showed that the gender variable affects the hopes and goals of the secondary school students towards STEM education and that expectations and interests of female students in STEM education were generally higher than male students. Similarly, Karakaya et al. (2018) revealed that levels of interest of female students towards STEM professions were higher than that of male students. Contrary to this finding, the study conducted by Christensen and Knezek (2017) concluded that male students were more interested in STEM education than females. Another study emphasized that attitudes of students towards STEM did not differ significantly according to the gender variable (Aydın et al., 2017).

Looking at the hopes and goals of the secondary school students towards STEM education according to grade level, it was found in this study that the total score in the survey differs significantly, in favor of younger graders. Considering the sub-scales of the hopes and goals towards STEM education survey, it was found that the "attitudes towards science" sub-scale scores of the 6th grader students were higher than those of 8th-grade students, and also the "attitudes towards mathematics" sub-scale scores of the 7th−grade students were higher than those of 8th-grade students. According to these results, it can be stated that younger students were more interested in STEM fields than the others. The TIMMS 2015 exam results also support the finding that interest in STEM decreases as the grade level increases. Of the 4th−grade students who took this exam, 84% was very interested in science, and 83% was very interested in mathematics. Nevertheless, it was found that the interest of the students in science and mathematics decreases in the 8th-grade level. Of the 8th−grade students who took the exam, 67% was found to be very interested in science, and 60% of them was found to be very interested in mathematics (TIMMS, 2016). Likewise, in a study conducted by Karakaya and Avgın (2016), it was found that students' attitudes towards STEM decrease as the grade level increases. It is important to introduce individuals with engineering knowledge and skills at a young age, to integrate engineering knowledge and skills into the science and mathematics curricula, and to improve out-of-school activities in order to guide their interests and career choices (Ayar & Saka, 2014).

Considering the hopes and goals of the secondary school students towards STEM education according to maternal education levels, it was found in this study that the total score of the students in the survey differs significantly, in favor of students with university graduate mothers. As a result of this analysis, it can be concluded that students with university graduate mothers had higher scores in the hopes and goals towards STEM education than those with primary, middle, and high school graduate mothers. Looking at the sub-scales of the hopes and goals towards STEM education survey, it was determined that students' learning in school hope has differed significantly according to mother education level in favor of university graduate mothers, but it was also determined that there was no significant mean difference in other sub-dimensions of this scale according to the education level of the mother. Similar to this finding, Karakaya and Avgın (2016) found that maternal education level is a factor affecting the attitudes of 6th, 7th, and 8th−grade students towards STEM. In addition, Uğraş (2019) found that the interests of secondary school students in STEM professions differed significantly in terms of maternal education levels.

It's also shown in this study that pseudoscience beliefs of the secondary school students differ significantly by gender, in favor of female students. Considering the sub-scales of the pseudoscience belief scale, only the pseudo-medical claims sub-scale was found to differ by gender, in favor of female students. According to this result, it can be stated that the gender variable is a factor affecting the pseudoscience beliefs of secondary school students and that the female students generally had more pseudoscience beliefs than male students. Looking at the literature, however, it was found that pseudoscience beliefs did not statistically change according to gender variable (Kirman Çetinkaya, 2013; Başer Gülsoy et al., 2015; Şenler & İrven, 2016). In addition, according to Eder et al. (2011), female secondary school students generally have paranormal beliefs more than males.

In this study, it was found that the hopes and goals of the secondary school students towards STEM education did not differ significantly according to paternal education level. In other words, paternal education level had no effect on the hopes and goals of the secondary school students towards STEM education. Aydın et al. (2017) also found that the maternal and paternal education levels did not affect the attitudes of students towards STEM education. However, in their study, Karakaya and Avgın (2016) found that paternal education level is a factor that affects attitudes of secondary school students towards STEM. A similar result was obtained in the study conducted by Uğraş (2019), who reported that the interests of secondary school students towards STEM professions differed significantly according to the paternal education level. Considering the pseudoscience beliefs of the secondary school students by grade level, it was found that the pseudo-physical claims and pseudo-medical claims sub-scale scores of the students significantly differ by grade level, in favor of upper graders. Therefore, it can be concluded that pseudoscience beliefs of students increase in line with the increase in grade level. In addition, it was also found that the pseudoscience beliefs of secondary school students did not differ significantly in terms of maternal and paternal education levels. Accordingly, it can be stated that the education level of the parents has no effect on the pseudoscience beliefs of secondary school students.

A positive and significant correlation was found between the students’ pseudo-medical claims and their hopes and goals towards STEM education. Moreover, there was a positive and significant correlation between the students’ pseudo-medical claims and the learning in school hope. On the other hand, there was a negative and significant correlation between the learning in school hope and pseudo-predictive claims of the students. In addition, there was a negative and significant correlation between the job satisfaction hope and pseudo-predictive claims of the students. In the study of Eder et al. (2011), all paranormal beliefs sub-scale scores, such as acceptance of creationism and intelligent design, were found to decrease in eighth graders. However, acceptance of natural evolution was not associated with age or degree. According to Martin (1994), pseudoscience and paranormal beliefs are important but neglected aspects of science education. Science educators need to focus on the problem of widespread acceptance of pseudoscience and paranormal beliefs, as well as the ways to fight against these beliefs. He proposed teaching science students to critically evaluate pseudoscience and paranormal claims, in a variety of ways. Secondary school students were very naive about the purpose, effectiveness, and scientific basis of pseudoscience practices (Metin et al., 2020).

In primary school, after a year-long professional learning program for teachers and the implementation of several integrated STEM projects with 3rd-grade students, students were more positive about STEM subjects and using STEM in their future careers. Of the interviewed students, those who carried out numerous projects under the supervision of their teachers reported that they preferred to learn mathematics and science with the help of projects and would like to have more opportunities in this regard (Anderson et al., 2019). Thanks to the technologically supported applications in laboratories, the STEM education contributes to students' achievement in courses in high school, improves their responsibilities in homework, helps them enroll in a good university, and have a job they love in the future. Since mathematics course is a common and compulsory course in all academic fields, it contributes positively to the attitudes of all students. If the students are engineering-oriented, these activities develop very positive attitudes in science students' learning about science and engineering, their orientation towards the engineering profession, and their motivation to become a science teacher. The use of technologically supported applications in mathematics courses as well as in physics, chemistry, and biology courses within the scope of science in laboratories enables students to develop positive professional and academic attitudes

(Kumaş, 2021). Moreover, attending a STEM activity helps elementary school students to develop perceptions about STEM subjects and future career aspirations (Pumphrey, 2017). Recent studies also show that changes in goals and hopes of the students towards STEM education can be determined by various STEM interventions. Since change is an inherent part of human nature, the goals and hopes, and pseudoscience beliefs of students can be different in different time periods. Comprehensive, further research is needed to reveal the variables that cause a change in the hopes and goals of the students and their pseudoscience beliefs. However, it should be kept in mind that these structures may change according to the conditions of that period, students' needs, age, and profile.

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