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Research Article

High school students' opinions on the distinction between science and pseudoscience

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Abstract

Nowadays, scientific advancements continue at an extraordinary pace, which leads to the widespread use of scientific expressions in many aspects of daily life. On social media and in print media platforms, we also witness the use of non-scientific expressions alongside scientific ones. The main aim of this study is to identify high school students' opinions regarding the distinction between real science and pseudoscience and to explore how these opinions may vary depending on factors such as gender, grade level, and type of school. The study employed a quantitative approach and used the relational survey model method. The research was conducted with 655 high school students studying in the central district of Tokat province during the 2022–2023 academic year. The variables of the study were gender, grade level, and type of school. Data were collected using the "Science-Pseudoscience Distinction Scale," which consists of 23 items—12 positive and 11 negative. The scale is a five-point Likert type, with responses ranging from "Strongly Disagree" to "Strongly Agree." The possible score range on the scale is 23–115 points. Arithmetic mean, independent samples t-test, and one-way analysis of variance (ANOVA) were used for data analysis. While no significant differences were observed concerning gender, variations were detected for other variables. Overall, it was found that high school students' ability to distinguish between science and pseudoscience was good but not at a sufficient level. Consequently, students are at risk of encountering potential material and moral harm through pseudoscience. Based on the results of the study, various recommendations were made to the Ministry of National Education, the Provincial Directorate of National Education, municipalities, school administrations, and teachers.

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Introduction

When stating "Knowledge is power," Bacon was, in fact, referring to scientific knowledge. Today, considering the level of development achieved by countries, it can be seen that those following the path of scientific knowledge affirm Bacon's famous quote. However, when it comes to defining the concept of science, which is expected to lead us to such empowering knowledge, many thinkers have approached it from various perspectives. From ancient times to the present, numerous philosophers and scientists have worked on the concept of science and attempted to define it. However, due to the methods used in science, the subjects it addresses, and its constantly evolving dynamic nature, a clear and universally accepted definition has not been established (Yıldırım, 2010).

Einstein (1940) defined science as the process of making sense of the complexities of our sensory experiences through a logical system of thinking. Neuman (2006) described science as a system that produces knowledge. Çepni (2007)

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defined science as the organization of knowledge gained through systematic methods, correct thinking, and research to understand the universe. Despite these various definitions, there has been no consensus regarding the definition of science. Tutar (2014), after analyzing many definitions, stated that science involves objective and intellectual activities and is based on systematic experimentation. He also emphasized that science aims to establish scientific laws, referencing Russell's definition.

Currently, the Turkish Language Association (2021) defines science as structured knowledge aimed at deriving conclusions about the universe through experimental methods. When examining these definitions, it becomes evident that no consensus has been reached on a common definition of science. Tutar (2014) attributes this to the expansion of science and the inability to clearly define its boundaries. Furthermore, Tutar (2014) suggests that a definition of science should include certain common criteria: unbiased observation, systematic experimentation, and intellectual activity.

The concept of "pseudoscience" was introduced by Popper (1962), who argued that if a doctrine cannot be falsified through testing, it should be classified as pseudoscience. Martin (1994) defined pseudoscience as well-compiled ideas, processes, and attitudes that appear scientific. Shermer (1997) similarly described pseudoscience as arguments that appear scientific but lie outside scientific methods and laws. Supporting Shermer, Swanson (2016) defined pseudoscience as claims that appear scientific but are not grounded in the scientific method. Shermer emphasized that pseudoscience is based on belief and, therefore, cannot be tested, identifying this as the primary distinction between science and pseudoscience. Atasoy (2020) defined pseudoscience as content that lacks verifiability in terms of scientificity but appears scientific. Hansson (2008), drawing on various definitions, outlined the characteristics of pseudoscience: it is tied to political or administrative power, cannot be experimentally replicated, selectively chooses sample groups for observation, disregards falsifiable information, resists innovation, and employs fraudulent methods. Atasoy (2020) further stated that pseudoscience emerges in many areas of life, is used for economic gain, and can influence not only individuals but also societies and governments. Miandji (2019) argued that pseudoscience, which is promoted for credibility, employs methods such as drawing from traditions, utilizing the placebo effect, and harboring confirmation bias.

Arık (2016) noted that despite numerous definitions and studies on the characteristics of science and pseudoscience, distinguishing between the two remains a philosophical problem and a practical issue in everyday life. Castelao (2002) suggested that the inability to distinguish pseudoscience from science could be attributed to a lack of scientific literacy among individuals and the media's support of pseudoscience. Turgut (2009) supported Castelao's view, highlighting the lack of scientific literacy as the fundamental problem and emphasizing the need to cultivate individuals with these competencies. Popper (1934) emphasized the importance of the inductive method in distinguishing science from pseudoscience, noting that pseudoscience derives strength from this method. He argued that science and pseudoscience could be distinguished through the criterion of falsifiability, stating that while we may not be able to prove or verify something, we can test and demonstrate its falsity. Uslu (2011) supported Popper's approach with the example of swans, noting that while it is difficult to prove that all swans are white, observing a single non-white swan would suffice to disprove the claim. Kuhn (1962) offered a different perspective on the distinction between science and pseudoscience, arguing that it is difficult to falsify scientific theories and introducing the concept of paradigms. He emphasized that for a concept to be considered scientific, it must be supported and shared by members of the scientific community. Kuhn termed the shift in paradigms a scientific revolution, noting that paradigms can change within society. Thagard (1978) offered a more radical perspective, arguing that using fixed criteria to distinguish science from pseudoscience is inappropriate, as such criteria can become obstacles for scientists. A key issue in distinguishing science from pseudoscience has been whether it is possible to establish a standard criterion for defining something as scientific. Philosophers associated with the Vienna Circle, such as Popper, Kuhn, and Lakatos, argued that rather than a single criterion, multiple criteria should be employed (as cited in Arık, 2016). Bunge (1984) drew an analogy with gold, suggesting that just as gold possesses multiple properties, something must exhibit multiple characteristics to be considered scientific. Feyerabend (1989), on the other hand, provided a radical critique, arguing that setting criteria is unnecessary (as cited in Arık, 2016).

Atasoy (2020) linked the logic of scientificity to reliability, arguing that the methods used should be systematic to achieve scientificity. Sánchez (2020) proposed a 50-year timeframe for establishing the scientific validity of a claim, suggesting that if a claim cannot be proven within fifty years, it should be considered unscientific. He also emphasized that claims should be provable, testable, and replicable to meet the criteria of scientificity. In light of these discussions, the inability of thinkers and scientists to reach a consensus on the definition of science may be attributed to the expanding scope of the scientific method and the dynamic nature of science.

Significance of the Study

The constructivist educational approach, adopted in 2005, provides students with the opportunity to build new knowledge based on their prior learning experiences. Therefore, determining students' views on science and pseudoscience is of great importance for understanding their current perspectives. Through quality education, students can develop strategies to counter non-scientific influences and revise their educational processes accordingly. With such an educational approach, students can enhance their scientific literacy skills and develop an effective defense against misleading non-scientific information.

Related Studies

Afonso and Gilbert (2010) conducted a study titled *"Pseudo-science: A Meaningful Context for Assessing Nature of Science"* with 45 university (science) students. The results indicated that students had an insufficient level of knowledge regarding the criteria for distinguishing between science and pseudoscience, and many held pseudoscientific beliefs.

Losh and Nzekwe (2010), in their study *"Creatures in the Classroom: Preservice Teacher Beliefs About Fantastic Beasts, Magic, Extraterrestrials, Evolution and Creationism,"* worked with 663 university students from various departments. The study revealed that students' level of scientific literacy was basic; most students did not believe in evolution but did believe in astrology, thus holding pseudoscientific beliefs.

Turgut, Akçay, and İrez (2010), in their study *"The Impact of the Science-Pseudoscience Distinction Debate on Pre-Service Teachers' Beliefs about the Nature of Science,"* conducted research with 38 pre-service science teachers. In this experimental study, an astrology case was used to improve students' beliefs about science, and the results showed a positive development in these beliefs.

Hooten (2011), in *"An Analysis of Science Versus Pseudoscience,"* examined studies on science and pseudoscience from 1976 to 2006. The study found that pseudoscientific beliefs existed across different geographical regions in the United States and that these beliefs did not vary significantly between regions.

Çetinkaya (2012), in *"The Impact of the Science-Pseudoscience Distinction Debate on 8th Grade Students' Perceptions of Scientificity and Academic Knowledge Levels,"* worked with 21 8th-grade students. The study found that students perceived sensory propositions as scientific, but classroom activities improved their perceptions of the science-pseudoscience distinction.

Çetinkaya (2013), in *"An Examination of Pre-Service Science Teachers' Pseudoscientific Beliefs Based on Gender, Grade, and Type of Education,"* conducted research with 138 pre-service science teachers. The results showed that students had a moderate level of knowledge regarding the science-pseudoscience distinction.

Sağır and Kılıç (2013), in *"The Impact of Science-Focused Discussion-Based Teaching on Elementary Students' Understanding of the Nature of Science,"* studied 89 8th-grade students. The study concluded that students had an insufficient understanding of the nature of science.

Gül (2016), in *"Pre-Service Biology, Physics, and Chemistry Teachers' Understanding of the Science-Pseudoscience Distinction,"* conducted research with 289 university students. The study evaluated students' understanding based on gender, grade, and department, finding a moderate level of understanding.

Kaplan (2014), in *"Research on the Pseudoscientific Beliefs of Pre-Service Science Teachers: A Sample from Astronomy-Astrology,"* conducted research with 29 pre-service science teachers. The study revealed that students perceived astrology as a science.

Sözcü (2015), in *"7th Grade Students' Mental Models Related to the Value of Scientificity,"* conducted research with 311 7th-grade students. The study found that female students had more scientific models than male students; after the experimental study, male students' scientific models improved more significantly.

Ağlarcı and Kabapınar (2016), in *"Improving Pre-Service Chemistry Teachers' Views on Science and Pseudoscience,"* conducted research with 20 pre-service chemistry teachers. The study found that students could make logical distinctions between science and pseudoscience and had knowledge about the characteristics of science.

Arık (2016), in *"The Impact of Argumentation-Based Learning on 7th Grade Students' Awareness of the Science-Pseudoscience Distinction,"* conducted research with 24 7th-grade students. The study observed that argumentation improved students' perceptions of the science-pseudoscience distinction.

Ayvacı and Bağ (2016), in *"An Investigation of Pre-Service Primary Teachers' Views on the Science-Pseudoscience Distinction,"* conducted research with 153 pre-service primary teachers. The study found that students had insufficient knowledge about the science-pseudoscience distinction but sufficient views regarding the scientific method.

Metin and Ertepınar (2016), in *"Inferring Pre-Service Science Teachers' Understanding of Science by Using Socially Embedded Pseudoscientific Context,"* conducted research with 41 pre-service science teachers. The study found that students held pseudoscientific beliefs related to earthquakes and could not provide scientific explanations to distinguish between science and pseudoscience.

Turgut et al. (2016), in *"Pre-Service Preschool Teachers' Perceptions of Science and Pseudoscience,"* conducted research with 41 pre-service preschool teachers. The study found that students used scientific concepts (proof, evidence, experiment, observation, research) when defining science but lacked sufficient knowledge to distinguish between science and technology.

Saka and Sürmeli (2017), in *"Pre-Service Science Teachers' Use of the Nature of Science in Pseudoscientific Scenarios,"* conducted research with 47 pre-service science teachers. The study revealed that while students used concepts such as experiment, observation, scientific method, and evidence when distinguishing science from pseudoscience, they were still influenced by pseudoscientific beliefs.

Uçar and Şahin (2018), in *"Pre-Service Science Teachers' Discrimination Level of Science and Pseudoscience,"* conducted research with 123 pre-service science teachers. The study found that students' beliefs tended to favor pseudoscience over science.

Arık and Akçay (2018), in *"The Impact of Argumentation on Students' Ability to Distinguish Science from Pseudoscience,"* conducted research with 24 7th-grade students. The experimental study showed that argumentation improved students' ability to distinguish between science and pseudoscience and enhanced their discussion skills.

Canan (2019), in *"An Investigation of Middle School Students' Perceptions of Science and Pseudoscience through Concept Cartoons,"* conducted research with 129 middle school students. The study found that students' knowledge levels regarding the science-pseudoscience distinction were quite low.

Gürgil (2019), in *"An Investigation of Pre-Service Social Studies Teachers' Tendencies to Distinguish Science and Pseudoscience,"* conducted research with 323 university students. The study concluded that students experienced confusion regarding the science-pseudoscience distinction and that male students had higher knowledge levels than female students.

Kaygısız (2019), in *"Pre-Service Primary Teachers' Views on the Science-Pseudoscience Distinction,"* conducted research with 156 pre-service primary teachers. The experimental study found that a course on the nature of science positively influenced students' views on the science-pseudoscience distinction.

Miandji (2019), in *"A Study on Pseudoscientific Practices in Turkey,"* conducted a literature review. The study found that a lack of scientific knowledge in society led to an inability to distinguish between science and pseudoscience and that religious communities influenced scientific activities.

Sayhan (2019), in *"Determining the Scientific Process Skills of Gifted 4th Grade Students through Pseudoscientific Practices,"* conducted research with 20 gifted students. The study found that students had low awareness of scientific processes, did not believe in pseudoscientific activities but were curious about them, and were unaware of those who sought financial gain through pseudoscience.

Şenler and İrven (2019), in *"Pre-Service Primary Teachers' Epistemological Beliefs and Pseudoscientific Beliefs,"* conducted research with 377 pre-service primary teachers. The study found that students had low knowledge levels regarding the science-pseudoscience distinction and that there were no gender differences in this regard.

Yardımcı (2019), in *"Science and Pseudoscience: Identifying the Nature of the Scientific Community and a Social Criterion for Distinguishing Pseudoscience,"* conducted a literature review. The study concluded that traditional approaches overlooked characteristics unique to science.

Duruk and Akgün (2020), in *"The Representation of Components of the Nature of Science in Science Textbooks,"* conducted a literature review. The study found that middle school science textbooks did not contain sufficient information regarding the science-pseudoscience distinction.

Ünal (2020), in *"Pre-School Teachers' Distinction between Science and Pseudoscience: Astronomy and Astrology,"* conducted research with 115 pre-service preschool teachers. The study found that students could not clearly distinguish between science and pseudoscience.

Purpose of the Study

The primary aim of this study is to reveal high school students' views regarding the distinction between science and pseudoscience. It is acknowledged that the ability to distinguish between science and pseudoscience is of great importance for this segment of young individuals, who can be considered the architects of the future. Today, the meanings attributed to pseudoscience reduce young people's interest, respect, and trust in real science. Therefore, it is intended to foster greater trust in science among those young people who are able to make this distinction, thereby increasing their interest in scientific fields. At the same time, it is believed that young people who can distinguish between science and pseudoscience will be able to prevent the misleading effects of pseudoscience (such as alternative medicine, astrology, etc.). In this context, the scientific literacy skills that young people capable of making this distinction will possess can be considered among the 21st-century skills, and it is believed that these skills will help shape them into more well-equipped individuals for the future. Accordingly, in line with the purpose of this study, it aims to reveal high school students' views regarding the science-pseudoscience distinction. In line with this aim, the study also seeks to answer whether students' views on the distinction between science and pseudoscience differ according to gender, grade level, and type of school.

Method

Research Model

In this study, a correlational survey model was chosen to determine high school students' views regarding the distinction between science and pseudoscience. The correlational survey model is generally a non-influential and non-interventionist model that describes past or present situations as they are (Karasar, 2008). This model has the capability to determine whether there is any change or relationship between variables, and if so, to what degree (Karasar, 2008).

Study Group

This study is based on research conducted with 655 high school students studying in Tokat province during the 2022–2023 academic year. The demographic characteristics of the study group are presented in Table 1. In selecting the study group, a non-probability sampling method (convenience sampling) was employed. This type of sampling was chosen because it allows for faster and easier data collection (Baltacı, 2018). Yıldırım and Şimşek (2006) also considered this method as an easy way to include individuals in the study group. However, Yıldırım and Şimşek (2000) noted that it might be difficult to obtain impartial and sincere data when collecting data from participants within one's own institution using this sampling method.

Table 1. Demographic characteristics of the study group

Variable	Frequency	Percentage (%)
Gender		
Female	305	46.6
Male	350	53.4
Total	655	100
Grade Level		
9th Grade	245	37.4
10th Grade	144	22.0
11th Grade	154	23.5
12th Grade	112	17.1
Total	655	100
Type of School		
Vocational High School	166	25.3
Anatolian High School	226	34.5
Social Sciences High School	133	20.3
Science High School	130	19.9
Total	655	100

Data Collection Instruments

In this study, the "Science-Pseudoscience Distinction Scale," developed by Oothoudt in 2008 and adapted into Turkish by Kirman Çetinkaya in 2013, was used to collect data. This scale consists of 23 items, 11 of which are negative statements and 12 positive statements. A five-point Likert scale was used to capture participants' opinions (Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree). Additionally, the data collection instrument consists of four sub-dimensions: scientific process, science-pseudoscience distinction, pseudoscience, and pseudoscientific beliefs.

Data Collection Process

Following the permission obtained from the researcher who adapted the data collection instrument into Turkish, and subsequent approval from the Tokat Provincial Directorate of National Education, the data collection instrument was administered to students studying in Tokat province during the 2022–2023 academic year. After obtaining the necessary permissions, the data collection instrument was transferred to an electronic format and made available to the students in the study group. The form was structured in two stages: in the first stage, demographic information of the students was collected; in the second stage, the scale items were presented. The electronic form was configured to allow each student to submit a response only once, and a 20-day window was provided for completion. At the end of this period, the data collection process was concluded. The collected data were first transferred to an Excel spreadsheet and subsequently imported into SPSS software for analysis.

Data Analysis

Data were analyzed using SPSS for Windows version 22. In the analysis, arithmetic mean, independent samples t-test, and one-way analysis of variance (ANOVA) were employed. The scoring key presented in Table 2 was used during data analysis. Items were scored from 5 (highest) to 1 (lowest), moving from positive to negative statements. When constructing the scoring key, the highest value was subtracted from the lowest value and divided by four. The reason for dividing by four was that the researchers aimed to classify the scale ratings as poor, moderate, good, and very good. Consequently, the scale interval was calculated as 1 [(5-1)/4=1]. These values were also used in the interpretation of the data.

Table 2. Scoring range

Level	Score Range
Poor	1 – 2
Moderate	2.01 – 3
Good	3.01 – 4
Very Good	4.01 – 5

Findings

The findings regarding the overall mean scores obtained by high school students from the data collection instrument on the distinction between science and pseudoscience are presented in Table 3.

Table 3. Descriptive statistics of overall mean scores on the scale

	N	Minimum	Maximum	Mean (x̄)	SD (S)
Total	**655**	1.30	4.43	3.17	0.38

The lowest mean score obtained from the data collection instrument was 1.30, while the highest was 4.43. Based on the data presented in Table 3, it can be stated that the average score of high school students on the instrument was 3.17, which corresponds to a *Good* level according to the scale's scoring key. However, the wide range between the minimum and maximum scores is also noteworthy and draws particular attention.

Table 4. Independent samples t-Test results according to gender variable

Sub-Dimensions	Gender	N	Mean (x̄)	SD (S)	t	df	p
SP (Scientific Process)	Female	305	3.2096	0.34079	2.35	651	0.19
	Male	350	3.1406	0.40763			
SD (Science-Pseudoscience Distinction)	Female	305	3.7672	0.40332	-0.636	648	0.52
	Male	350	3.7898	0.50477			
SPD (Pseudoscience and Pseudoscientific Beliefs)	Female	305	2.8350	0.65190	1.9	647	0.57
	Male	350	2.7352	0.68485			
PB (Pseudoscientific Beliefs)	Female	305	3.0454	0.37957	2.67	643	0.008
	Male	350	2.9543	0.49180			
Overall Mean Score	Female	305	3.0404	0.87704	2.32	652	0.20
	Male	350	2.8714	0.98135			

When Table 4 is examined, the overall mean score of female students on the scale is 3.04, while that of male students is 2.87. Statistically, it can be stated that the overall mean scores on the scale do not differ significantly according to the gender variable ($p < .20$). However, when the scoring key is taken into consideration, it can be interpreted that female students' overall knowledge level regarding the distinction between science and pseudoscience is at a *Good* level, whereas male students' level is at a *Moderate* level.

Table 5. ANOVA results according to grade level variable

Total Score		Sum of Squares	df	Mean Square	F	p
SP (Scientific Process)	Between Groups	1.876	3		0.625	2.980
	Within Groups	136.582	651		0.210	
	Total	138.458	654			
SD (Science-Pseudoscience Distinction)	Between Groups	4.638	3		1.546	3.472
	Within Groups	289.865	651		0.445	
	Total	294.502	654			
SPD (Pseudoscience and Pseudoscientific Beliefs)	Between Groups	0.168	3		0.056	0.282
	Within Groups	129.396	651		0.199	
	Total	129.564	654			
PB (Pseudoscientific Beliefs)	Between Groups	8.681	3		2.894	3.329
	Within Groups	565.913	651		0.869	
	Total	574.593	654			
Overall Mean Score	Between Groups	0.805	3		0.268	1.874
	Within Groups	93.266	651		0.143	
	Total	94.071	654			

When Table 5 is examined, it is observed that there is no statistically significant difference (p > .05) in the sub-dimensions of the Science-Pseudoscience Distinction Scale (SP, SD, SPD, PB) or in the overall mean score based on the students' grade level variable (9th Grade, 10th Grade, 11th Grade, 12th Grade).

Table 6. Mean scores of sub-dimensions and overall scale score according to grade level

Sub-Dimension / Overall Mean	Grade Level	N	Mean ($\bar{x}$)
SP (Scientific Process)	9th Grade	245	2.9848
	10th Grade	144	3.0149
	11th Grade	154	3.0111
	12th Grade	112	2.9770
SD (Science-Pseudoscience Distinction)	9th Grade	245	3.7475
	10th Grade	144	3.7540
	11th Grade	154	3.8757
	12th Grade	112	3.7487
SPD (Pseudoscience and Pseudoscientific Beliefs)	9th Grade	245	2.7388
	10th Grade	144	2.9039
	11th Grade	154	2.6840
	12th Grade	112	2.8527
PB (Pseudoscientific Beliefs)	9th Grade	245	2.8585
	10th Grade	144	3.1597
	11th Grade	154	2.9069
	12th Grade	112	2.9405
Overall Mean	9th Grade	245	3.1363
	10th Grade	144	3.2304
	11th Grade	154	3.1753
	12th Grade	112	3.1747

When Table 6 is examined, the overall mean scores of the 9th-grade students were found to be 3.13, the 10th-grade students 3.23, the 11th-grade students 3.17, and the 12th-grade students 3.17. Both statistically and according to the scoring key of the scale, it can be stated that there is no differentiation among the grade levels. It can also be interpreted that students at all grade levels have a *Good* level of understanding regarding the distinction between science and pseudoscience.

Table 7. ANOVA results according to type of school variable

Total Score	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
SP (Scientific Process)	Between Groups	16.251	3	5.417	31.122
	Within Groups	113.313	651	0.174	
	Total	129.564	654		
SD (Science-Pseudoscience Distinction)	Between Groups	2.148	3	0.716	3.419
	Within Groups	136.310	651	0.209	
	Total	138.458	654		
SPD (Pseudoscience and Pseudoscientific Beliefs)	Between Groups	118.916	3	39.639	146.964
	Within Groups	175.586	651	0.270	
	Total	294.502	654		
PB (Pseudoscientific Beliefs)	Between Groups	157.621	3	52.540	82.029
	Within Groups	416.972	651	0.641	
	Total	574.593	654		
Overall Mean Score	Between Groups	34.068	3	11.356	123.204
	Within Groups	60.003	651	0.092	
	Total	94.071	654		

When Table 7 is examined, it is observed that there are significant differences ($p < .05$) in the sub-dimensions of the Science-Pseudoscience Distinction Scale (SP, SD, SPD, PB), as well as in the overall mean score, according to the type of school variable (Vocational High School, Anatolian High School, Social Sciences High School, Science High School). To determine between which types of schools these differences exist, it was decided to perform a multiple comparison test. To select the appropriate multiple comparison test, the homogeneity of variances was first examined.

Table 8. Levene's test of equality of variances for the pseudoscience sub-dimension

Sub-Dimension	**Levene's Test**	**df1**	**df2**	**Sig.**
SP (Scientific Process)	0.839	3	651	0.473

When Table 8 is examined, it is observed that the data for the Pseudoscience sub-dimension are normally distributed. Therefore, it was decided to use the LSD multiple comparison test to determine between which types of schools the differences in the Pseudoscience sub-dimension occur.

Table 9. LSD multiple comparison test results for the pseudoscience sub-dimension

Type of School	Compared With	Mean Difference	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Vocational High School	Anatolian High School	0.05577	0.04265	0.191	-0.0280
	Social Sciences High School	0.01023	0.04855	0.833	-0.0851
	Science High School	-0.36411*	0.04886	0.000	-0.4601
Anatolian High School	Vocational High School	-0.05577	0.04265	0.191	-0.1395
	Social Sciences High School	-0.04554	0.04559	0.318	-0.1351
	Science High School	-0.41988*	0.04592	0.000	-0.5101
Social Sciences High School	Vocational High School	-0.01023	0.04855	0.833	-0.1056
	Anatolian High School	0.04554	0.04559	0.318	-0.0440
	Science High School	-0.37434*	0.05146	0.000	-0.4754
Science High School	Vocational High School	0.36411*	0.04886	0.000	0.2682
	Anatolian High School	0.41988*	0.04592	0.000	0.3297
	Social Sciences High School	0.37434*	0.05146	0.000	0.2733

When Table 9 is examined, it is observed that in the Pseudoscience sub-dimension of the scale, there are significant differences between students attending Science High Schools and those attending Vocational High Schools, Anatolian High Schools, and Social Sciences High Schools. No significant differences were found between the other types of schools.

Table 10. Mean scores of the pseudoscience sub-dimension according to type of school

Type of School	N	Mean ($\bar{x}$)
Vocational High School	166	2.9458
Anatolian High School	226	2.8900
Social Sciences High School	133	2.9356
Science High School	130	3.3099
Total	655	2.9967

When the mean scores of the Pseudoscience sub-dimension according to type of school (Table 10) are examined — considering the scoring range of the scale — it was determined that students in Vocational High Schools, Anatolian High Schools, and Social Sciences High Schools had a *Moderate* level of knowledge regarding pseudoscience, whereas students in Science High Schools had a *Good* level of knowledge regarding pseudoscience.

It was then decided to perform a multiple comparison test to determine between which types of schools differences exist in the Scientific Process sub-dimension. In order to select the appropriate multiple comparison test, the homogeneity of variances was examined.

Table 11. Levene's test of equality of variances for the scientific process sub-dimension

Sub-Dimension	Levene's Test	df1	df2	Sig.
SP (Scientific Process)	0.205	3	651	0.893

When Table 11 is examined, it is observed that the data for the Scientific Process sub-dimension are normally distributed. Therefore, it was decided to use the LSD multiple comparison test to determine between which types of schools the differences in the Scientific Process sub-dimension occur.

Table 12. LSD multiple comparison test results for the scientific process sub-dimension

Type of School	Compared With	Mean Difference	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Vocational High School	Anatolian High School	-0.02621	0.04677	0.575	-0.1181
	Social Sciences High School	-0.15187*	0.05325	0.004	-0.2564
	Science High School	-0.09617	0.05359	0.073	-0.2014
Anatolian High School	Vocational High School	0.02621	0.04677	0.575	-0.0656
	Social Sciences High School	-0.12566*	0.05001	0.012	-0.2239
	Science High School	-0.06996	0.05037	0.165	-0.1689
Social Sciences High School	Vocational High School	0.15187	0.05325	0.004	0.0473
	Anatolian High School	0.12566*	0.05001	0.012	0.0275
	Science High School	0.05570	0.05644	0.324	-0.0551
Science High School	Vocational High School	0.09617	0.05359	0.073	-0.0091
	Anatolian High School	0.06996	0.05037	0.165	-0.0289
	Social Sciences High School	-0.05570	0.05644	0.324	-0.1665

When Table 12 is examined, it is observed that in the Scientific Process sub-dimension of the scale, there are significant differences between students attending Vocational High Schools and those attending Social Sciences High Schools, and between students attending Anatolian High Schools and those attending Social Sciences High Schools. No significant differences were found between the other types of schools.

Table 13. Mean scores of the scientific process sub-dimension according to type of school

Type of School	N	Mean ($\bar{x}$)
Vocational High School	166	3.7203
Anatolian High School	226	3.7465
Social Sciences High School	133	3.8722
Science High School	130	3.8165
Total	655	3.7793

When Table 13 is examined — considering both the mean scores of the Scientific Process sub-dimension according to type of school and the scale's scoring range — it was determined that students from Vocational High Schools, Anatolian High Schools, Social Sciences High Schools, and Science High Schools all demonstrated a *Good* level of knowledge regarding the Scientific Process. Although statistically, students from Social Sciences High Schools differed from those in Vocational and Anatolian High Schools in terms of their knowledge level of the Scientific Process, it can be interpreted that this difference is not practically significant when considering the scale's scoring range; thus, no meaningful differentiation exists across the different school types regarding the Scientific Process sub-dimension.

Table 14. Levene's test of equality of variances for the science-pseudoscience distinction sub-dimension

Sub-Dimension	Levene's Test	df1	df2	Sig.
Science-Pseudoscience Distinction (SPD)	7.299	3	651	0.000

When Table 14 is examined, it is observed that the data for the Science-Pseudoscience Distinction sub-dimension do not exhibit a normal distribution ($p < .05$). Therefore, it was decided to use the Games-Howell multiple comparison test to determine between which types of schools the differences in the Science-Pseudoscience Distinction sub-dimension occur.

Table 15. Games-Howell multiple comparison test results for the science-pseudoscience distinction sub-dimension

Type of School	Compared With	Mean Difference	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Vocational High School	Anatolian High School	0.00795	0.05117	0.999	-0.1241
	Social Sciences High School	0.10065	0.05729	0.296	-0.0474
	Science High School	-1.03522*	0.06660	0.000	-1.2075
Anatolian High School	Vocational High School	-0.00795	0.05117	0.999	-0.1400
	Social Sciences High School	0.09270	0.05292	0.299	-0.0441
	Science High School	-1.04317*	0.06288	0.000	-1.2059
Social Sciences High School	Vocational High School	-0.10065	0.05729	0.296	-0.2487
	Anatolian High School	-0.09270	0.05292	0.299	-0.2295
	Science High School	-1.13587*	0.06796	0.000	-1.3117
Science High School	Vocational High School	1.03522*	0.06660	0.000	0.8630
	Anatolian High School	1.04317*	0.06288	0.000	0.8804
	Social Sciences High School	1.13587*	0.06796	0.000	0.9601

When Table 15 is examined, it is observed that in the Science-Pseudoscience Distinction sub-dimension of the scale, there are significant differences between students attending Science High Schools and those attending other types of schools. No significant differences were found between the other types of schools.

Table 16. Mean scores of the science-pseudoscience distinction sub-dimension according to type of school

Type of School	N	Mean ($\bar{x}$)
Vocational High School	166	2.5994
Anatolian High School	226	2.5914
Social Sciences High School	133	2.4987
Science High School	130	3.6346
Total	655	2.7817

When Table 16 is examined — considering both the mean scores of the Science-Pseudoscience Distinction sub-dimension according to type of school and the scale's scoring range — it was determined that students in Vocational High Schools, Anatolian High Schools, and Social Sciences High Schools had a *Moderate* level of knowledge regarding the distinction between science and pseudoscience, whereas students in Science High Schools demonstrated a *Good* level of knowledge in this sub-dimension.

Table 17. Levene's test of equality of variances for the pseudoscientific beliefs sub-dimension

Sub-Dimension	Levene's Test	df1	df2	Sig.
Pseudoscientific Beliefs (PB)	2.369	3	651	0.070

When Table 17 is examined, it is observed that the data for the Pseudoscientific Beliefs sub-dimension are normally distributed. Therefore, it was decided to use the LSD multiple comparison test to determine between which types of schools the differences in the Pseudoscientific Beliefs sub-dimension occur.

Table 18. LSD multiple comparison test results for the pseudoscientific beliefs sub-dimension

Type of School	Compared With	Mean Difference	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Vocational High School	Anatolian High School	0.01230	0.08181	0.881	-0.1483
	Social Sciences High School	-0.08367	0.09314	0.369	-0.2666
	Science High School	-1.24257*	0.09373	0.000	-1.4266
Anatolian High School	Vocational High School	-0.01230	0.08181	0.881	-0.1729
	Social Sciences High School	-0.09597	0.08746	0.273	-0.2677
	Science High School	-1.25487*	0.08810	0.000	-1.4279
Social Sciences High School	Vocational High School	0.08367	0.09314	0.369	-0.0992
	Anatolian High School	0.09597	0.08746	0.273	-0.0758
	Science High School	-1.15890*	0.09871	0.000	-1.3527
Science High School	Vocational High School	1.24257*	0.09373	0.000	1.0585
	Anatolian High School	1.25487*	0.08810	0.000	1.0819
	Social Sciences High School	1.15890*	0.09871	0.000	0.9651

When Table 18 is examined, it is observed that in the Pseudoscientific Beliefs sub-dimension of the scale, there are significant differences between students attending Science High Schools and those attending other types of schools. No significant differences were found between the other types of schools.

Table 19. Mean scores of the pseudoscientific beliefs sub-dimension according to type of school

Type of School	N	Mean ($\bar{x}$)
Vocational High School	166	2.6908
Anatolian High School	226	2.6785
Social Sciences High School	133	2.7744
Science High School	130	3.9333
Total	655	2.9501

When Table 19 is examined — considering both the mean scores of the Pseudoscientific Beliefs sub-dimension according to type of school and the scale's scoring range — it was determined that students in Vocational High Schools, Anatolian High Schools, and Social Sciences High Schools had a *Moderate* level of knowledge regarding pseudoscientific beliefs, whereas students in Science High Schools demonstrated a *Good* level of knowledge in this sub-dimension.

Table 20. Levene's test of equality of variances for the overall scale

Sub-Dimension	Levene's Test	df1	df2	Sig.
Overall Mean Score	0.251	3	651	0.861

When Table 20 is examined, it is observed that the data for the overall scale are normally distributed. Therefore, it was decided to use the LSD multiple comparison test to determine between which types of schools the differences in the overall mean score occur.

Table 21. LSD multiple comparison test results for the overall scale

Type of School	Compared With	Mean Difference	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Vocational High School	Anatolian High School	0.01267	0.03103	0.683	-0.0483
	Social Sciences High School	-0.02777	0.03533	0.432	-0.0971
	Science High School	-0.57222*	0.03556	0.000	-0.6420
Anatolian High School	Vocational High School	-0.01267	0.03103	0.683	-0.0736
	Social Sciences High School	-0.04044	0.03318	0.223	-0.1056
	Science High School	-0.58489*	0.03342	0.000	-0.6505
Social Sciences High School	Vocational High School	0.02777	0.03533	0.432	-0.0416
	Anatolian High School	0.04044	0.03318	0.223	-0.0247
	Science High School	-0.54445*	0.03744	0.000	-0.6180
Science High School	Vocational High School	0.57222*	0.03556	0.000	0.5024
	Anatolian High School	0.58489*	0.03342	0.000	0.5193
	Social Sciences High School	0.54445*	0.03744	0.000	0.4709

When Table 21 is examined, it is observed that in the overall scale, there are significant differences between students attending Science High Schools and those attending other types of schools. No significant differences were found between the other types of schools.

Table 22. Mean scores of the overall scale according to type of school

Type of School	N	Mean ($\bar{x}$)
Vocational High School	166	3.0579
Anatolian High School	226	3.0452
Social Sciences High School	133	3.0856
Science High School	130	3.6301
Total	655	3.1727

When Table 22 is examined — considering both the overall mean scores of the scale according to type of school and the scale's scoring range — it was determined that although statistically, students from Science High Schools demonstrated different knowledge levels regarding the distinction between science and pseudoscience compared to students from Vocational High Schools, Anatolian High Schools, and Social Sciences High Schools, all school types overall demonstrated a *Good* level of understanding regarding the distinction between science and pseudoscience. Therefore, in practical terms, it can be interpreted that no meaningful differentiation exists across the different school types regarding this distinction.

Conclusion and Discussion

When the minimum and maximum scores, the arithmetic mean score obtained from the scale, and the scoring key are evaluated together, the high school students' average score of 3.17 corresponds to a *Good* level according to the scoring key. Although this is classified as "good," it indicates that high school students are not yet fully capable of distinguishing between science and pseudoscience. Therefore, it can be said that high school students remain vulnerable to manipulation by malicious individuals who exploit pseudoscience, are at risk of drifting away from scientific thinking due to such manipulations, and are exposed to potential financial and moral harm. Researchers have also detected that students hold pseudoscientific beliefs. Furthermore, this finding aligns with the results of studies conducted by Peña and Paco (2004), Afonso and Gilbert (2010), Losh and Nzekwe (2010), Çetinkaya (2013), Sağır and Kılıç (2013), Gül (2016), Kaplan (2014), Ayvacı and Bağ (2016), Metin and Ertepınar (2016), Saka and Sürmeli (2017), Uçar and Şahin (2018), Canan (2019), Şenler and İrven (2019), and Ünal (2020), all of whom reported that the students in their study groups were unable to clearly distinguish between science and pseudoscience.

The scores obtained from the general scale and its sub-dimensions were analyzed according to the gender variable using an independent samples t-test. No significant differences were found in the Pseudoscience, Scientific Process, or Science-Pseudoscience Distinction sub-dimensions based on gender. Students' levels in the Pseudoscience and Scientific Process sub-dimensions were *Good*, and in the Science-Pseudoscience Distinction sub-dimension, there was no gender difference and students' levels were *Moderate*. These results parallel those of Şenler and İrven (2019), who also found no gender-based differences regarding the distinction between science and pseudoscience.

Although there were no statistically significant differences in the Pseudoscientific Beliefs sub-dimension or in the overall scale score based on gender, differences were observed when interpreted according to the scoring key. In the Pseudoscientific Beliefs sub-dimension, female students demonstrated a *Moderate* level while male students reached a *Good* level. Regarding the overall scale, female students were at a *Good* level, while male students were at a *Moderate* level. This finding is consistent with Sözcü (2015), who reported that female students had more advanced scientific models than male students. However, it contrasts with the findings of Gürgil (2019), who found that female students' knowledge levels regarding the distinction between science and pseudoscience were lower than those of male students. Considering these results, the higher levels of female students in distinguishing between science and pseudoscience may indicate that female students are more exposed to pseudoscientific influences, have greater interest in pseudoscience, and have developed greater awareness than their male counterparts.

The scores obtained from the general scale and its sub-dimensions were also analyzed according to the grade level variable using ANOVA. Although ANOVA revealed no significant differences between grade levels, an interpretation based on the scoring key shows that 9th-grade students had *Moderate* knowledge levels in the SP, SPD, and PB sub-dimensions, and *Good* levels in the SD sub-dimension and the overall scale. For 10th-grade students, knowledge levels were *Moderate* in SP and SPD, and *Good* in SD, PB, and overall. For 11th-grade students, knowledge levels were *Moderate* in SPD and PB, and *Good* in SP, SD, and overall. Similarly, 12th-grade students showed *Moderate* levels in SPD and PB, and *Good* levels in SP, SD, and overall. These findings are consistent with those of Solomon et al. (1992) and Williams, Francis, and Robbins (2007), who found that students held pseudoscientific beliefs and were vulnerable to negative influences. It can be inferred that students across grade levels do not possess advanced knowledge to effectively distinguish between science and pseudoscience and remain susceptible to misinformation. It was expected that a significant difference would emerge between grade levels due to the increasing emphasis on scientific literacy, the nature of science, and related outcomes in the curriculum from 9th to 12th grade. The absence of such a difference suggests that the curriculum content regarding science and scientific literacy has not produced the desired impact on students.

The scores obtained from the general scale and its sub-dimensions were further analyzed according to the type of school variable using ANOVA. Students in Vocational, Anatolian, and Social Sciences High Schools demonstrated a *Moderate* level of knowledge in the Pseudoscience sub-dimension, while Science High School students showed a *Good* level. No significant differences were observed in the Scientific Process sub-dimension; all school types demonstrated a *Good* level of knowledge in this area. In the Science-Pseudoscience Distinction sub-dimension, Science High School students demonstrated a *Good* level of knowledge and significantly outperformed students from other types of schools, who remained at a *Moderate* level. Similarly, in the Pseudoscientific Beliefs sub-dimension, Science High School students demonstrated a *Good* level of knowledge and outperformed students from other schools, who again remained at a *Moderate* level. Although Science High School students differed statistically in the overall scale score, all school types demonstrated a *Good* level of knowledge regarding the distinction between science and pseudoscience when considering the scoring range. These findings parallel those of Williams, Francis, and Robbins (2007), who found that students aged 13–16 held pseudoscientific beliefs.

Interestingly, despite expectations that students from the most academically prestigious schools (Social Sciences and Science High Schools) would score at the highest levels, their results did not fully meet these expectations. This suggests that high school students in general are not fully capable of making clear distinctions between science and pseudoscience. The relatively higher performance of Science High School students may be attributed to the intensive focus on positive sciences (biology, chemistry, physics) and rational disciplines (such as mathematics) in their curriculum.

Recommendations

It is recommended that the Ministry of National Education increase the inclusion of learning outcomes related to science, the nature of science, the scientific method, and scientific literacy in the curriculum. Additionally, introducing a dedicated "Science" course within the curriculum is suggested. This recommendation is supported by the findings of Duruk and Akgün (2020), who reported that science textbooks do not provide sufficient information to help distinguish between science and pseudoscience.

Provincial directorates of national education and school administrations should encourage students to participate in scientific projects and provide high-level guidance to ensure that students experience and learn the scientific method through hands-on activities.

Many studies have indicated that teachers themselves are not at the desired level of competence regarding the distinction between science and pseudoscience. Therefore, it is recommended that teacher guidebooks include activities aimed at improving teachers' knowledge and understanding of this distinction.

Teachers should, as much as possible, emphasize science, the importance of science, and scientific principles in their lessons to increase students' awareness in these areas. To raise public awareness of the financial and moral harm that malicious individuals can inflict through pseudoscience, collaborations between police departments, municipalities, and schools should be established. Public campaigns, including billboards, print and visual media, and social media platforms, should be used effectively to inform students, parents, and teachers about the potential harms of pseudoscience through public service announcements and educational materials.

The findings of this study indicate that the current curriculum does not effectively foster students' understanding of science, the nature of science, and scientific literacy. Therefore, educational programs should be reviewed and revised to include more effective teaching methods that promote scientific thinking.

The study found no significant differences in scientific understanding across grade levels. However, considering that students' conceptual understanding may evolve with grade level, curriculum content and instructional modules should be tailored accordingly to address the specific needs of each grade level.

Students from Science High Schools demonstrated higher performance compared to those from other types of schools. This finding highlights the need for special emphasis on science education in Science High Schools. More advanced components of science education could be introduced, and specialized instructional designs could be encouraged in these schools.

It is also crucial to raise awareness among the general public and society to help individuals resist pseudoscientific beliefs. Resources should be provided to families to guide them on how to foster scientific thinking, and public awareness campaigns should be expanded to reach broader audiences.

Limitations

This study is limited to the study group of students from Tokat province and to the data collected using the measurement instrument employed in the research. To enable more reliable assessments, it is recommended that future studies utilize different measurement tools and compare the data obtained through various instruments.

References

Afonso, A. S. ve Gilbert, J. K. (2010). Pseudo-science: A Meaningful Context for Assessing Nature of Science. *International Journal of Science Education,* 32 (3), 329–348.

Ağlarcı, F. ve Kabapınar, F. (2016). Kimya Öğretmen Adaylarının Bilime ve Sözde Bilime İlişkin Görüşlerinin Geliştirilmesi. *Amasya Üniversitesi Eğitim Fakültesi Dergisi*, 5 (1), 248-286.

Arık, M. (2016). *Argümantasyon Tabanlı Öğrenme Yönteminin Yedinci Sınıf Öğrencilerinin Bilim Sözde-Bilim Ayrımı Farkındalığının Geliştirilmesi Üzerine Etkisi.* Yayınlanmamış Yüksek lisans Tezi. İstanbul Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Arık, M. ve Akçay, B. (2018). Argümantasyonun Öğrencilerin Bilimi Sözde-Bilimden Ayırma Becerilerinin Geliştirilmesi Üzerine Etkisi. *Sakarya University Journal of Education, 8*(1), 41-60.

Atasoy, G. (2020). Bilim, Sözdebilim Ayrımı Bağlamında Tasarlanan Etkinliklerin 7. Sınıf Öğrencilerinin Sözde Bilimsel İnançları, Bilimsellik Ölçütleri ve Eleştirel Düşünme Becerilerine Etkisi. Yayımlanmamış Yüksek Lisans Tezi. Kocaeli Üniversitesi Fen Bilimleri Enstitüsü, Kocaeli.

Ayvacı, H. Ş. ve Bağ, H. (2016). Sınıf Öğretmeni Adaylarının Bilim Sözde-Bilim Ayrımına İlişkin Görüşlerinin İncelenmesi. *Amasya Üniversitesi Eğitim Fakültesi Dergisi*, 5(2), 539-566.

Baltacı, A. (2018). Nitel Araştırmalarda Örnekleme Yöntemleri ve Örnek Hacmi Sorunsalı Üzerine Kavramsal Bir İnceleme. *Bitlis Eren Üniveristesi Sosyal Bilimler Enstitüsü Dergisi*, 7(1), 231-274.

Bunge, M. (1984). What is pseudoscience. *Skeptical Inquirer*, *9*(1), 36-46.

Büyüköztürk, Ş. (2013). *Bilimsel Araştırma Yöntemleri*. Ankara: Pegem Akademi

Canan, L., N. (2019). Ortaokul Öğrencilerinin Bilim-Sözde Bilim Algılarının Kavram Karikatürleri Aracılığıyla İncelenmesi. Yayımlanmamış Yüksek Lisans Tezi. Necmettin Erbakan Üniversitesi Eğitim Bilimleri Enstitüsü, Konya.

Castelão, T. (2002). Epistemology of Science, Science Literacy, and The Demarcation Criterion: The Nature of Science (NOS) and Informing Science (IS) in Context. *Informing Science and IT Education Joint Conference*: InSITE "Where Parallels Intersect": 251-260.

Çepni, S.(2007). Bilim, fen, teknoloji kavramlarının eğitim programlarına yansımaları, Kuram ve uygulamaya fen ve teknoloji öğretimi, S. Çepin (Ed.). Ankara: Pegem A Yayıncılık.

Çetinkaya, E. (2012). *Bilim Sözde-Bilim Ayrımı Tartışmasının Ortaokul 8. Sınıf Öğrencilerinin Bilimsellik Algıları ve Akademik Bilgi Düzeylerine Etkisi.* Yayınlanmamış Yüksek lisans Tezi. Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Çetinkaya, E., K. (2013). *Fen Bilgisi Öğretmen Adaylarının Sözde-Bilimsel İnanışlarının Cinsiyet, Sınıf ve Öğrenim Türüne Göre incelenmesi*, Yayınlanmamış Yüksek Lisans Tezi, Sakarya Üniversitesi Eğitim Bilimleri Enstitüsü, Sakarya.

Duruk, Ü. ve Akgün, A. (2020). Bilimin Doğası Bileşenlerinin Fen Bilimleri Ders Kitaplarında Temsil Edilme Durumu. *Amasya Üniversitesi Eğitim Fakültesi Dergisi* 9(2), 196-229.

Einstein, A. (1940). *Considerations Concerning the Fundaments of Theoretical Physics*. Science, 91 (2369), 487-492.

Gül, Ş. (2016). Biyoloji, fizik ve kimya öğretmeni adaylarının bilim-sözde bilim ayrımı anlayışları. *Kuramsal Eğitimbilim Dergisi [Journal of Theoretical Educational Science], 9*(2), 177-197.

Gürgil, F. (2019). Sosyal Bilgiler Öğretmeni Adaylarının Bilim-Sözde Bilim Ayrımı Eğilimlerinin İncelenmesi. *Tarih Okulu Dergisi*, 42: 965-984.

Hansson, S., O. (2008*). Science and Pseudo-Science*. http://meb.ai/JU2MUv Erişim Tarihi: 20/11/2022.

Hooten, J. T. (2001). An Analysis of Science Versus Pseudoscience. Yayınlanmamış Doktora Tezi, Teksas A ve M Üniversitesi-Ticaret Yüksek Okulu Fakültesi, ABD.

Kaplan, A. O. (2014). Research on the Pseudo-Scientific Beliefs of Pre-Service Science Teachers: A Sample from Astronomyastrology. *Journal of Baltic Science Education*, *13*(3), 381-393.

Karasar, N. (2008). *Bilimsel Araştırma Yöntemi*, Nobel Yayıncılık, Ankara.

Kaygısız (2019). Sınıf Öğretmen Adaylarının Bilim, Sözde-Bilim Ayrımına İlişkin Görüşleri. 6. Uluslararası Multidisiplinler Çalışmaları Kongresi. Hasan Kalyoncu Üniversitesi, Gaziantep.

Kuhn, T. S. (1962*). The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Lederman, N. G. (1999). Teachers' Understanding of The Nature of Science And Classroom Practice: Factors That Facilitate or İmpede The Relationship. *Journal of Research in Science Teaching*, *36(8)*, 916-929.

Losh, S. C. ve Nzekwe, B. (2010). Creatures in the classroom: Preservice teacher beliefs about fantastic beasts, magic, extraterrestrials, evolution and creationism. *Science & Education*, *20(5-6),* 473–489.

Martin, M. (1994). Pseudoscience, The Paranormal, and Science Education. *Science & Education*. *3(4)*, 357-371, doi: 10.1007/BF00488452Oothoudt, B. (2008). *Development of an Instrument to Measure Understanding of The Nature of Science as a Process of Inquıry in Comparison to Pseudoscience*. (Unpublished Master Thesis) California State University, Department of Science Education.

Metin, D. ve Ertepinar, H. (2016). Inferring Pre-Service Science Teachers" Understanding of Science by Using Socially Embedded Pseudoscientific Context. *International Journal of Education in Mathematics, Science and Technology*, 4(4), 340-358.

Miandji, A. (2019). Türkiye'de Sözdebilim Uygulamaları Üzerine Bir Çalışma (Türler ve Teknikler), Doktora Tezi, Ankara Üniversitesi Sosyal Bilimler Enstitüsü, Ankara.

Neuman, W. L. (2006). *Toplumsal Araştırma Yöntemleri Nitel ve Nicel Yaklaşımlar*. (Çeviren: Sedef

Oothoudt, B. (2008). Development of an Instrument to. 3(4), 357-371, doi: 10.1007/BF00488452

Pena, A. ve Paco, O. (2004) Attitudes and Views of Medical Students toward Science and Pseudoscience. *Medical Education Online. 9 (4),* 1-7.

Popper, K. (1962). *Conjectures and refutations: The growth of scientific knowledge*,

Popper, K. R. (1934). *Logik der Forshung*. Viyana: Julius Springer Press.

Russell, B. (1935). *Religion and Science*. Thornton Butterworth Ltd, London.

Sağır, Ş. U. ve Kılıç, Z. (2013). İlköğretim öğrencilerinin bilimin doğasını anlama düzeylerine bilimsel tartışma odaklı öğretimin etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *44*(44).

Saka, M. ve Sürmeli, H. (2017). Fen Bilgisi Öğretmen Adaylarının Sözde Bilimsel Senaryolarda Bilimin Doğası Kullanımı. *Trakya Üniversitesi Eğitim Fakültesi Dergisi,* 7(2), 504-525.

Sánchez M. V. (2019). Four Examples of Pseudoscience, *Philosophy*, 1-46.

Sayhan, E., B. (2019). Sözde-Bilim Uygulamaları Yoluyla Üstün Zekalı ve Yetenekli 4. Sınıf Öğrencilerinin Bilimsel Süreç Beceri Düzeylerinin Belirlenmesi, Yayınlanmamış Yüksek Lisans Tezi, Ege Üniversitesi Sosyal Bilimler Enstitüsü, İzmir.

Shermer, M. (1997). *İnsan Neden Saçma Şeylere İnanır*. Altın Bilek Yayınları. İstanbul.

Solomon, J., Duveen, J., Scot, L., ve McCarthy, S. (1992). Teaching about the nature of science through history: Action research in the classroom. *Journal of Research in Science Teaching*, *29(4)*, 409-421.

Sözcü, U. (2015). *7.Sınıf Öğrencilerinin Bilimsellik Değerine İlişkin Zihinsel Modelleri.* Yayınlanmamış Yüksek Lisans Tezi, Kastamonu Üniversitesi Sosyal Bilimler Enstitüsü, Kastamonu.

Swanson, E. S. (2016). Science and society: Understanding scientific methodology, energy, climate, and sustainability. doi:10.1007/978-3-319-21987-5 Tabachnick, B. G. & Fidel, L. S. (2001) Using multivariate statistics (6th edition). Boston: Pearson.

Şenler, B. ve İrven, Ö . (2016). Sınıf Öğretmeni Adaylarının Epistemolojik İnançları ile Sözde-Bilimsel İnançları. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, 12 (2): 659-671.

Thagard, P. R. (1978). Why astrology is a pseudoscience. In *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association* (pp. 223-234). Philosophy of Science Association.

Turgut, H. (2009). Fen ve Teknoloji Öğretmen Adaylarının Bilimsel, Sözde-Bilimsel Ayrımına Yönelik Algıları. *Eğitim ve Bilim Dergisi*, 34 (154), 50-68.

Turgut, H., Akçay, H. ve İrez, S. (2010). Bilim Sözde-Bilim Ayrımı Tartışmasının Öğretmen Adaylarının Bilimin Doğası İnanışlarına Etkisi. *Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory ve Practice* 10 (4), 2621-266

Turgut, H., Eş, H., Bozkurt Altan, E. ve Bozkurt Altan, N. (2016). Okul Öncesi Öğretmen Adaylarının Bilim, Sözde-Bilim Algıları. *International Online Journal of Educational Sciences,* 8 (1), 150-169.

Tutar, H. (2014). *Bilim ve Sözde Bilim* (1.baskı). Ankara: Seçkin Yayıncılık.

Türk Dil Kurumu (TDK) (2021). http://sozluk.gov.tr/bilim adresinden elde edilmiştir. Erişim Tarihi: 08.10.2022.

Uçar, M. B., & Sahin, E. (2018). Pre-service science teachers' discrimination level of science and pseudoscience. Science Education International, 29(4), 267-273.

Uslu, F. (2011). Bilimselliğin kriteri ve sınırları problemi-bilim, bilim olmayan ve sahte bilim. *Hitit Üniversitesi İlahiyat Fakültesi Dergisi*, *19*(19), 5-35.

Ünal, M. (2020). *Okul öncesi öğretmenlerinin bilim ve sözde bilim ayrımı: Astronomi ve astroloji, İnönü Üniversitesi Eğitim Fakültesi Dergisi*, *21*(2), 757-771.

Williams, E., Francis, L. J., ve Robbins, M. (2007). Personality and Paranormal Belief: A Study Among Adolescents. *Pastoral Psychology*, *56(1),* 9–14.

Yardımcı, A., B. (2019). "Bilim ve Sözde Bilim: Bilimsel Topluluğun Doğasının Belirlenmesi ve Sözde Bilimin Ayırt Edilmesine Yönelik Sosyal Bir Ölçüt," *Kaygı Dergisi*, 18(11): 567- 588.

Yıldırım K. (2010). Raising The Quality in Qualitative Research. *İlköğretim Online*, 9(1), 79-92.

Yıldırım, A. ve Şimşek, H. (2000). Nitel araştırma yöntemleri. Ankara: Seçkin Yayıncılık.