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Pre-Service Teachers' Levels of Distinguishing Science and Pseudoscience

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ABSTRACT

This study aims to examine whether pre-service teachers can distinguish between pseudoscience and science. A survey method was used in this study. Data were gathered from 307 pre-service teachers studying in various fields at a public institution. They were split into two categories: "Natural Science and Mathematics Teaching" and "Social Sciences and Art Teaching." A Likert scale was used, consisting of four factors: "Pseudoscience," "Scientific Methods," "Discrimination between Science and Pseudoscience," and "Pseudoscientific Beliefs." As a result, pre-service teachers have a poor understanding of pseudoscience. They also struggle to differentiate between pseudoscience and science. An adequate grasp of scientific technique does not contribute positively to their pseudoscientific ideas. It is especially evident among those in the Social Sciences and Art Teaching fields who have not received specialised training in the history and philosophy of science. However, no significant difference is found in terms of gender in all four factors.

Keywords: Pseudoscience, Pseudoscientific beliefs, Pre-service teachers, Fields, Gender

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1. Introduction

The term "pseudoscience" refers to beliefs and arguments that lack empirical backing, contradict accepted scientific principles, and employ scientific language to appear authentic (Shermer, 2002). When making crucial or life-altering decisions, raising awareness of the dangers of pseudoscientific beliefs and the benefits of science's nature is critical. Our students today digest a massive amount of information. They will vote on critical subjects like climate change, biotechnology, and other scientific phenomena in the future. Students must comprehend the science behind these issues (MacKenzie, 2020). According to a survey, 33% of American adults believe in reincarnation, 29% believe in astrology, and 42% believe spiritual energy may be found in tangible objects (Gecewicz, 2018). According to research in the US, pseudoscientific beliefs such as astrology, UFOs, lucky numbers, the sixth sense, ghosts, telekinesis, and telepathy are widespread (National Science Board, 2006). Hollins College in Virginia survey discovered that 37% of students believed in ghosts, 64% believed in telepathy, and 46% felt that talking to plants would make them grow quicker (Woods, 1984). Another study conducted in Montreal revealed that 55% believed in astrology; 85% of students believed in extrasensory perception (ESP), 49% in psychic healing, and 43% in ghosts (Gray, 1984). Such attitudes persist in the broader public (Silva & Woody, 2022). Females are more likely to have pseudoscientific ideas, particularly paranormal beliefs, according to a particular study (Gürgil, 2019; Preece & Baxter,

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2000; Sjödin, 2002; Williams et al., 2007). According to Preece and Baxter (2000), females are less sceptical of pseudoscientific claims. It could, however, be tied to the specific type of pseudoscientific notions. Males, for example, are more prone than females to believe in pseudoscientific assertions, such as the reality of UFOs and aliens. Conversely, females are more likely to trust in pseudoscientific claims such as fortune telling and horoscopes (Preece and Baxter, 2000).

According to one study of students' online reasoning skills, 96% of them did not realise why linkages between a climate change website and the fossil fuel sector may reduce the credibility of that website. Students were more concerned with the site's aesthetics, top-level domain, or how it depicted itself on the about page than with who was behind it (Breakstone et al., 2019). These findings imply that some societies struggle to discern between scientific and non-scientific thinking.

Although most scientists grasp the nature and limitations of science, students who do not entirely comprehend the Nature of Science (NOS) may find it more challenging to discern scientific discourses from actual knowledge. Many students value science so highly that they are uncritical of views that purport to be "scientific" (Keranto, 2001).

Numerous studies have been conducted on pseudoscience at various levels of education and with pre-service teachers (e.g. Ağlarcı & Kabapınar, 2016; Kızılcık, 2022; Kızılcık, 2024; Gül, 2016; Gürgil, 2019; Kirman-Çetinkaya & Laçin-Şimşek, 2012; Lundström & Jakobsson, 2009; Şenler & İrven, 2016; Turgut, 2007; Turgut, 2009; Uçar & Şahin, 2018). Numerous studies, including those conducted by Abd-El-Khalick, Waters and Le (2008), Altındağ, Tunç Şahin, and Saka (2012), and Irez (2008), have revealed that educational materials found in textbooks often contain numerous misconceptions and when pseudoscientific beliefs and misconceptions are combined, they can mislead students and hinder their ability to understand nature correctly. Therefore, addressing pseudoscientific beliefs within society while students are still in school is crucial.

First, teachers should be able to correctly distinguish between the scientific and the non-scientific to guide students. Whether pre-service teachers hold pseudoscientific beliefs is likely to impact the scientific thinking skills of their future students. It is challenging for a teacher with pseudoscientific beliefs to effectively help students distinguish between scientific and non-scientific beliefs. Teachers should acquire these skills during their pre-service training. Considering this, this study aims to examine whether pre-service teachers can distinguish between pseudoscience and science and the factors affecting this.

The research problem is as follows: What factors affect pre-service teachers' ability to distinguish between science and pseudoscience?

The sub-problems of the research are as follows:

- Do pre-service teachers distinguish between pseudoscience and science?
- Is there a relationship between pre-service teachers' pseudoscience understanding, knowledge of the scientific method, ability to distinguish between pseudoscience and science, and the existence of pseudoscientific beliefs?
- Is there a difference between pre-service teachers' pseudoscience understanding, knowledge of the scientific method, ability to distinguish between pseudoscience and science, and the existence of pseudoscientific beliefs according to academic fields?
- Do the conception of pre-service teachers' pseudoscience, knowledge of scientific method, ability to distinguish between pseudoscience and science, and the existence of pseudoscientific beliefs differ according to gender?

2. Methodology

This study used the survey approach to measure pre-service teachers' opinions about pseudoscience. The survey method is "questioning individuals on a topic or topics and then describing their

responses" (Jackson, 2011). Data acquired from pre-service instructors using a Likert scale were first examined descriptively, and then inferential statistics were applied.

2.1. Study Group

The study group consisted of 307 pre-service teachers selected randomly from the sophomore class of the Faculty of Education at a public university in Ankara in Türkiye. To ensure randomness, the scale was administered to students taking randomly selected common courses randomly selected by pre-service teachers from different departments. The sample was diverse, representing various fields of study, including science teaching (N=35), mathematics teaching (N=74), social sciences teaching (N=76), elementary school teaching (N=15), preschool teaching (N=11), language teaching (N=67), geography teaching (N=2), music teaching (N=4), art teaching (N=6), special education (N=5), and psychological counselling and guidance (N=12). To facilitate analysis, the participants were categorized into two groups: Natural Science and Mathematics Teaching (NSMT), which encompassed science and mathematics teaching, and Social Sciences and Art Teaching (SSAT), which encompassed the remaining fields. A detailed breakdown of the sample demographics is provided in Table 1.

Table 1. Demographics of the sample

Field / Gender	Female		Male		Undefined		Total	
	N	%	N	%	N	%	N	%
NSMT	89	28.99	20	6.51	0	.00	109	35.50
SSAT	161	52.44	36	11.73	1	.33	198	64.50
Total	250	81.43	56	18.24	1	.33	307	100.00

As indicated in Table 1, most pre-service teachers are female (81.43%), while the remaining percentage comprises males. Additionally, 35.50% of pre-service teachers are enrolled in NSMT, whereas 64.50% are pursuing studies in SSAT.

2.2. Data Collection and Analysis

The original Likert scale is the "Nature of Science Survey" developed by Oothoudt (2008), with 32 items. It was adapted into Turkish by Kirman-Çetinkaya, Şimşek-Laçin, & Çalışkan (2013), resulting in a 23-item version named the "Science Pseudoscience Discrimination Scale." This Turkish version of the scale was used in this study. The scale had been validated by the adapters with pre-service teachers from different departments beforehand. The scale is comprised of four factors: F1 "Pseudoscience," F2 "Scientific Methods," F3 "Discrimination between Science and Pseudoscience," and F4 "Pseudoscientific Beliefs." The scale items are presented in English in the appendix. The Cronbach's Alpha Coefficient was found to be .747.

Data were assessed using computer software. During the evaluation, items that represented negative expressions were coded inversely. In other words, for all items, a score of 1 represents the lowest scientific response, while a score of 5 represents the highest scientific response. Responses were categorized into distinct levels to interpret descriptive statistics.

The evaluation criteria were devised following the scale structure outlined by Kızılcık et al. (2007). All the scales employed in the study are five-point Likert scales. These measures utilize five-point Likert scales, so responses were categorized into five levels. Respondents could give each item a score ranging from 1 to 5. The possible score range was four. The evaluation criteria were calculated using the following formula, and the assessment criteria are shown in Table 2 and Figure 1 based on the evaluation range.

Evaluation Range = (Score range) / (Number of Categories) = (5-1) / 5 = 4 / 5 = 0.8 (Kızılcık et al., 2007)

Table 2. Assessment criteria

Level Range	Level
1.00 - 1.79	Very Low (VL)
1.80 - 2.59	Low (L)
2.60 - 3.39	Moderate (M)
3.40 - 4.19	High (H)
4.20 - 5.00	Very High (VH)

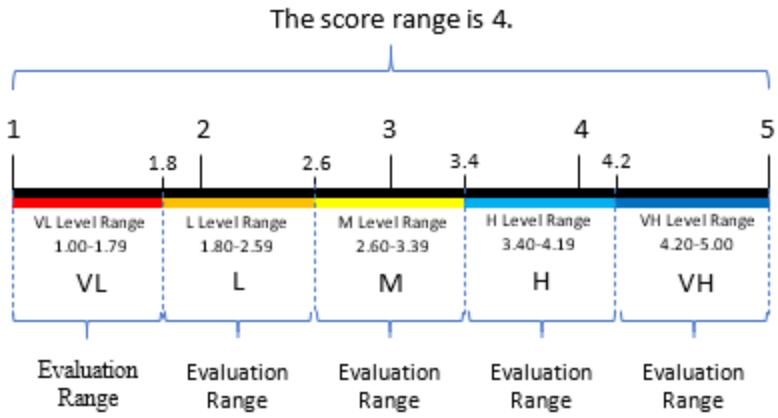

Figure 1. Visualisation of assessment criteria (Kızılcık, 2022)

As shown in Table 2, scores of 2.59 and below are considered low and very low, while scores of 3.40 and above are regarded as high and very high. Scores falling between 2.60 and 3.39 are considered to represent a moderate level.

3. Results

This section presented descriptive statistics first for data analysis, followed by inferential statistics.

3.1. Distinguishing Between Science and Pseudoscience

Initially, the analysis commenced by scrutinising pre-service teachers' responses to the scale and the various factors within the scale and each item. Frequency statistics for the items can be found in Table 3, while descriptive statistics for the scale, broken down by groups, are provided in Table 4.

Pre-service teachers appear to have a high knowledge of scientific methods but less about what pseudoscience entails. According to the criteria presented in Table 2, mean scores for F1 and F4 fall within the Moderate Level. On the other hand, mean scores for F2, F3, and the overall scale are categorised as High Level. Although pre-service teachers exhibit a high level of knowledge regarding scientific methods and the ability to distinguish between pseudoscience and science, it can be said that their understanding of pseudoscience is somewhat lacking, and they hold some pseudoscientific beliefs. Item 2 (F2) has the highest mean, while Item 6 (F1) has the lowest. Based on pre-service teachers' responses, while they have substantial knowledge of scientific methods, they may still have gaps in their understanding of pseudoscience. F2 has the highest means, while F1 has the lowest in all groups, regardless of field and gender.

Table 3. Frequency statistics of the scale

Factors	Item No	N	1 %	2 %	3 %	4 %	5 %	Means	Level	Std. Dev.	Var.
F1: Pseudo-Science	1	302	15.64	22.48	28.01	20.52	11.73	2.90	M	1.24	1.55
	6	305	13.03	27.69	25.73	24.76	8.14	2.87	M	1.17	1.37
	9	306	14.98	27.69	19.87	24.10	13.03	2.92	M	1.28	1.64
	11	305	10.42	21.82	29.32	24.10	13.68	3.09	M	1.20	1.43
	14	304	12.05	20.52	33.22	21.82	11.40	3.00	M	1.17	1.38
	17	305	13.03	19.87	31.60	26.06	8.79	2.98	M	1.16	1.35
	19	307	6.84	19.54	24.43	32.90	16.29	3.32	M	1.16	1.35
	Means	304.86	12.28	22.80	27.45	24.90	11.87	3.01	M	1.20	1.44
F2: Scientific Methods	2	305	3.58	1.63	1.30	28.99	63.84	4.49	VH	.90	.81
	5	306	1.63	.65	3.58	43.00	50.81	4.41	VH	.74	.55
	8	307	3.26	6.51	8.79	43.32	38.11	4.07	H	1.01	1.02
	10	306	2.28	1.95	2.61	45.93	46.91	4.34	VH	.82	.67
	12	304	1.95	3.58	8.79	54.07	30.62	4.09	H	.85	.72
	13	304	2.28	2.93	12.70	44.95	36.16	4.11	H	.90	.81
	22	307	22.48	39.09	9.12	11.73	17.59	2.63	M	1.41	1.98
	Means	305.57	5.35	8.05	6.70	38.86	40.58	4.02	H	.95	.94
F3: Discrimination between Science and Pseudoscience	3	302	11.07	17.92	25.41	26.71	17.26	3.22	M	1.25	1.57
	15	305	2.28	.65	2.93	30.29	63.19	4.52	VH	.79	.63
	16	307	12.38	9.45	46.91	20.20	11.07	3.08	M	1.11	1.23
	18	306	20.20	14.66	9.77	22.15	32.90	3.33	M	1.55	2.40
	21	305	18.24	13.03	12.38	25.08	30.62	3.37	M	1.49	2.22
	23	306	10.42	18.89	19.22	33.22	17.92	3.29	M	1.26	1.58
	Means	305.17	12.43	12.43	19.44	26.28	28.83	3.47	H	1.24	1.60
F4: Pseudoscientific Beliefs	4	304	12.70	24.76	31.27	17.26	13.03	2.93	M	1.21	1.46
	7	306	16.94	16.61	18.89	25.73	21.50	3.18	M	1.39	1.94
	20	307	6.51	11.07	35.50	35.18	11.73	3.35	M	1.04	1.08
	Means	305.67	12.05	17.48	28.56	26.06	15.42	3.15	M	1.21	1.49
General Means		305.26	10.18	14.91	19.19	29.66	25.49	3.46	H	1.13	1.34

Table 4. Group Means

Factors	*NSMT*		*SSAT*		*Total*		*Total*		*Total*
	Female	*Male*	*Female*	*Male*	*Female*	*Male*	*NSMT*	*SSAT*	
F1	3.08	3.01	2.97	3.02	3.01	3.02	3.07	2.98	3.01
F2	3.97	3.95	4.05	4.03	4.02	4.00	3.97	4.05	4.02
F3	3.79	3.42	3.31	3.47	3.48	3.45	3.73	3.33	3.47
F4	3.16	3.12	3.15	3.23	3.15	3.19	3.15	3.16	3.16
Total	3.55	3.42	3.41	3.47	3.46	3.45	3.52	3.42	3.46

Table 5. Descriptive statistics of the scale

Statistics	*F1*	*F2*	*F3*	*F4*	*Scale*
N	307	307	307	307	307
Mean	3.01	4.02	3.47	3.16	3.46
Median	3.00	4.00	3.67	3.33	3.48
Mode	2.71	4.14	3.67	3.00	3.43
Std. Deviation	.44	.54	.83	.71	.35
Variance	.20	.29	.69	.50	.12
Skewness	.020	-.870	-.476	-.316	-.510
Std. Error of Skewness	.139	.139	.139	.139	.139
Kurtosis	-.118	1.900	-.760	.605	1.012
Std. Error of Kurtosis	.277	.277	.277	.277	.277

The assessment of kurtosis and skewness values for the scale and its factors can provide insights into the normality of the data distribution. "A kurtosis value between 1.0 is considered excellent for most psychometric purposes, but a value between 2.0 is, in many cases, also acceptable, depending on the specific application," write George and Mallery (2012). Hair, Black, Babin, Anderson, and Tatham (2013) also state: "Skewness is a measure of the symmetry of the distribution, often compared to a normal distribution. Skewness values falling outside the range of -1 to +1 indicate a significantly skewed distribution." According to Table 5, the data has a normal distribution. The mean and median values are closely aligned, indicating a normal distribution. Figure 2 depicts the scale's distribution curves.

3.2. Relationship between Factors

Given the normal distribution of the data, metric statistical methods were employed to conduct inferential analyses to test hypotheses. The data were examined independently and comprehensively, considering fields of study and genders as separate categories.

The Pearson Correlation Coefficient was utilized to explore potential relationships between the variables. The results of the correlations between the components, categorized by field of study, are presented in Table 6. Notably, the most significant findings have been highlighted in bold.

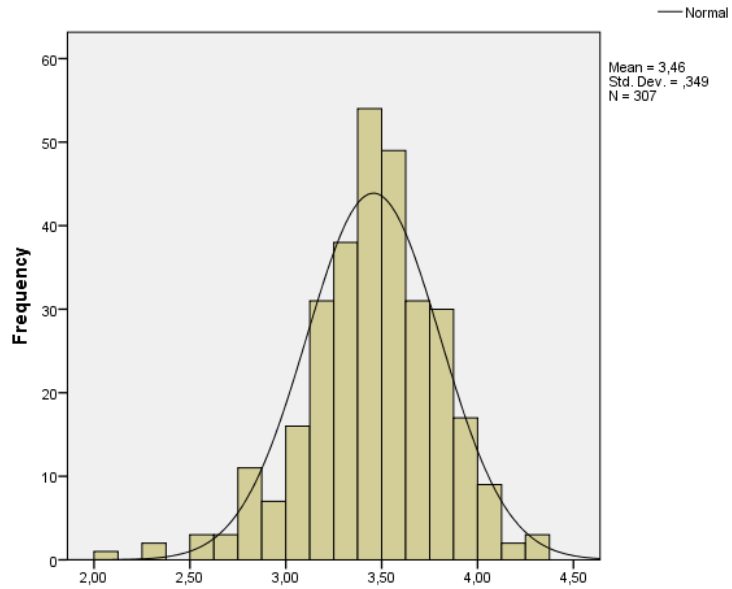

Figure 2. The distribution curve of the scale

Table 6. Correlations between the factors of the scale by fields (P<0.5)

		F1			F2			F3			F4		
		NSMT	SSAT	Total	NSMT	SSAT	Total	NSMT	SSAT	Total	NSMT	SSAT	Total
F1	r	1	1	1									
	p	*	*	*									
	N	109	198	307									
F2	r	.090	-.057	-.019	1	1	1						
	p	.354	.425	.739	*	*	*						
	N	109	198	307	109	198	307						
F3	r	**.229**	**.209**	**.228**	-.011	**-.192**	**-.158**	1	1	1			
	p	**.017**	**.003**	**.000**	.906	**.007**	**.005**	*	*	*			
	N	**109**	**198**	**307**	109	**198**	**307**	109	198	307			
F4	r	**.212**	**.191**	**.196**	-.135	.027	-.017	**.490**	**.341**	**.368**	1	1	1
	p	**.027**	**.007**	**.001**	.162	.705	.769	**.000**	**.000**	**.000**	*	*	*
	N	**109**	**198**	**307**	109	198	307	**109**	**198**	**307**	109	198	307

According to Table 6, total F2 is not correlated with F1 and F4. All other factors are correlated with each other. The findings highlighted that knowledge of scientific methods is not related to pseudoscience and having pseudoscientific beliefs. On the other hand, relationships have been found between the knowledge of pseudoscience and the reduction of pseudoscientific beliefs and better discrimination between science and pseudoscience. In the field SSAT and total, findings are similar. However, in the field NSMT, there is no relationship between F2 and F3.

While there are strong relationships between what pseudoscience is and having pseudoscientific ideas, there are none between knowing scientific procedures and them. Furthermore, a substantial positive association was discovered between awareness of pseudoscience and science prejudice and holding pseudoscientific beliefs.

A negative substantial connection was discovered between scientific method knowledge, pseudoscience, and science discrimination in SSAT and total. NSMT, on the other hand, has no such relationship. Table 7 displays the gender-specific correlation findings. The most important ones are highlighted in bold.

Table 7. Correlations between the factors of the scale by gender (P<0.5)

		F1			F2			F3			F4		
		Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
	r	1	1	1									
F1	p	*	*	*									
	N	250	56	307									
	r	-.002	-.118	-.019	1	1	1						
F2	p	.980	.388	.739	*	*	*						
	N	250	56	307	250	56	307						
	r	**.223**	.255	**.228**	**-.154**	-.165	**-.158**	1	1	1			
F3	p	**.000**	.057	**.000**	**.015**	.224	**.005**	*	*	*			
	N	**250**	56	**307**	**250**	56	**307**	250	56	307			
	r	**.205**	.133	**.196**	-.011	-.062	-.017	**.394**	.261	**.368**	1	1	1
F4	p	**.001**	.328	**.001**	.861	.652	.769	**.000**	.052	**.000**	*	*	*
	N	**250**	56	**307**	250	56	307	**250**	56	**307**	250	56	307

According to Table 7, no significant relationship was found in males in any factor. However, it is seen that all factors that are significant in total are also significant in females. It can be said that the significance in total is due to females.

3.3. Difference between Fields

The group means barely differ from one another in any noticeable ways. However, it is essential to consider whether the changes are significant. A t-test is performed between fields. Table 8 displays the t-test results for each field.

Table 8 demonstrates that there is a sizable distinction between F3 and total. There is no significant difference in other factors. The differences are in favour of NSMT. The NSMT group has a significantly higher mean in F3 and total. That is, the NSMT group can discriminate between pseudoscience and science better. However, there is no significant difference between the fields regarding knowledge of scientific methods, what pseudoscience is, and pseudoscientific beliefs.

Table 8. T-test results between by-field groups (P<0.5)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
F1	Equal variances	.342	.559	1.621	305	.106	.08552	.05274	-.01826	.18930
	Not Equal variances			1.628	225.432	.105	.08552	.05252	-.01797	.18900
F2	Equal variances	5.186	.023	-1.260	305	.209	-.08101	.06429	-.20752	.04550
	Not Equal variances			-1.342	265.186	.181	-.08101	.06037	-.19987	.03786
F3	Equal variances	24.063	.000	4.067	305	.000	.39409	.09690	.20341	.58477
	Not Equal variances			4.381	272.659	.000	.39409	.08996	.21699	.57119
F4	Equal variances	2.183	.141	-.146	305	.884	-.01237	.08474	-.17912	.15438
	Not Equal variances			-.152	251.440	.879	-.01237	.08120	-.17229	.14756
Total	Equal variances	3.675	.056	2.497	305	.013	.10301	.04125	.02184	.18417
	Not Equal variances			2.565	240.437	.011	.10301	.04016	.02389	.18213

3.4. Difference between Genders

An independent sample t-test is performed to compare genders. Table 9 displays the t-test results by gender.

Table 9. T-test results between gender groups (P<0.5)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
F1	Equal variances	.733	.393	-.141	304	.888	-.00928	.06576	-.13868	.12013
	Not Equal variances			-.152	89.151	.879	-.00928	.06096	-.13041	.11185
F2	Equal variances	.105	.746	.176	304	.861	.01403	.07995	-.14329	.17135
	Not Equal variances			.188	88.145	.852	.01403	.07477	-.13456	.16262
F3	Equal variances	.373	.542	.235	304	.815	.02891	.12324	-.21361	.27143
	Not Equal variances			.223	77.237	.825	.02891	.12992	-.22978	.28759
F4	Equal variances	4.933	.027	-.392	304	.695	-.04122	.10518	-.24820	.16577
	Not Equal variances			-.486	110.382	.628	-.04122	.08484	-.20934	.12691
Total	Equal variances	1.292	.257	.084	304	.933	.00435	.05173	-.09744	.10613
	Not Equal variances			.089	87.401	.929	.00435	.04870	-.09245	.10115

Table 9 shows no significant difference in all factors and total by gender. No significant difference can be found between knowledge of scientific methods, what pseudoscience is, discrimination between science and pseudoscience, and pseudoscientific beliefs. It can be said that gender makes no significant difference in factors.

4. Discussion

Pre-service teachers have naive beliefs about pseudoscience. Although they better understand the scientific method, they have difficulty distinguishing between pseudoscience and science. Gürgil (2019) discovered that pre-service social science teachers had inadequate and inconsistent beliefs about science and pseudoscience. There is no significant relationship between knowing scientific methods and pseudoscientific beliefs. Additionally, a substantial positive association was discovered between knowledge of pseudoscience, bias towards science, and holding pseudoscientific beliefs. Non-scientific information can also impact pre-service teachers' everyday life (Saka & Sürmeli, 2017). Astrology is regarded as a science by the majority of pre-service teachers (Şenler & İrven, 2016). Similarly, most high school students believe in pseudoscientific notions such as mind-reading, telepathy, and the capacity of the lunar cycle to impact people's behaviour (Lundström & Jakobsson, 2009).

Having pseudoscientific ideas is strongly correlated with what pseudoscience is. According to studies, the distinction between science and pseudoscience is difficult for individuals to make (e.g., Afonso & Gilbert, 2010; Çetinkaya, Turgut, Duru, & Ercan, 2015; Turgut, 2009). When people know what pseudoscience is, they can differentiate it from science more effectively. Teachers and pre-service teachers in the fields of science, the social sciences, languages, and mathematics, as well as at various levels, are frequently undecided about pseudoscience and pseudoscientific beliefs and may have difficulty distinguishing between what is scientific and what is pseudoscientific (Ağlarcı & Kabapınar, 2016; Gül, 2016; Gürgil, 2019; Kirman-Çetinkaya & Laçin-Şimşek, 2012; Şenler & İrven, 2016; Turgut, 2009; Uçar & Şahin, 2018). Before starting their careers as teachers, pre-service educators should be able to tell the difference between science and pseudoscience (Turgut, 2007).

The NSMT group can discriminate between pseudoscience and science better. However, there is no significant difference between the fields regarding knowledge of scientific methods, what pseudoscience is, and pseudoscientific beliefs. According to Snow and Collini (2012), the NSMT and SSAT cultures have different perspectives on science. Courses in Philosophy of Science may be given separately in some NSMT departments. Therefore, it may be expected that NSMT departments will better understand science. However, they are similar regarding pseudoscientific beliefs because they have not been sufficiently warned about pseudoscience.

No significant difference is found between knowledge of scientific methods, what pseudoscience is, discrimination between science and pseudoscience, and pseudoscientific beliefs by gender. It can be said that gender makes no significant difference in factors. Similarly, some studies state that gender does not affect pseudoscientific beliefs (Kızılcık, 2022; Peltzer, 2003). Gender influences the types and levels of pseudoscientific views, according to particular studies (e.g., Gürgil, 2019; Preece & Baxter, 2000; Sjödin, 2002; Williams, Francis, & Robbins, 2007). Studies have shown that women are more likely than men to hold paranormal beliefs in things like psychic abilities, witchcraft, precognition, and alternative medicine (Aarnio & Lindeman, 2005; Mencken, Bader, Stark, 2008; Mencken, Bader, Kim, 2009; Wilson, 2018). In contrast, men are more likely to believe in extraterrestrial life (Wilson, 2018). The results of this inquiry challenge this idea.

5. Limitations and Suggestions

The research is limited to the factors specified in the scale content used. The research is limited to the participants' statements and the items' content due to the nature of the Likert scales. In addition, the research is limited to pre-service teachers. The fact that the number of males is less than females is one

of the limitations of this study. Because the number of females is higher than the number of males in the faculties of education in Türkiye.

Pre-service teachers who will educate future students should know what pseudoscience is. They should receive adequate training on this subject before they start to work. They also need to eliminate their pseudoscientific beliefs as much as possible.

6. Conclusion

Pre-service teachers' knowledge about pseudoscience is at the naive level. They also have difficulty distinguishing between pseudoscientific beliefs and scientific knowledge. Having sufficient knowledge about the method of science does not contribute positively to their pseudoscientific beliefs. This situation is more noticeable in the social fields who do not have special education in the history and philosophy of science.

Ethical Statement

The implementation of the study was previously approved by the data collected from the participants in this study were conducted in accordance with the ethics policy. Ethical approval to report this case was obtained from Gazi University Ethical Committee.

Declaration of Interest

The authors declare that they have no conflict of interest.

Informed Consent

The consent for the data collection and publication of all legal guardians was obtained.

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Appendix: Items of Science Pseudoscience Discrimination Scale

Item No	Item
1	Science cannot explain how those who pray to heal sick or injured people.
2	All variables should be taken into account in scientific research.
3	Astrologers can accurately predict the future and/or character of people using the stars in the sky.
4	There are extraterrestrials visiting the world.
5	Scientists support a hypothesis with scientific experiments.
6	Scientific experiments can be used to explain miracles.
7	Houses can be visited by ghosts of dead people.
8	It is important that all published results and findings have been checked by other scientists.
9	Science may cover topics such as supernatural phenomena, ghosts, super-sensory perceptions, and aliens.
10	Scientific research involves data collection through experiments.
11	Ghost hunters can support paranormal claims using scientific methods.
12	Hypotheses are guesses based on information.
13	The processes for collecting evidence for scientific results must be reproducible by other scientists.
14	Supernatural phenomena are not the subject of scientific experiments.
15	Scientific information can be revised or changed in the light of new evidence.
16	Placing a magnet on the body or close to the body for treatment is a valid medical method.
17	Supernatural phenomena can be explained by science.
18	Scientific knowledge is precise and unchangeable.
19	Science does not include such topics as ghosts and super-sensory perceptions.
20	Scientists can collect data to prove that aliens have visited Earth.
21	Some people can accurately describe their future by reading people's palms.
22	There are certain steps that scientists use when conducting scientific research.
23	Evidence for scientific knowledge is shared only between the people conducting the experiment.