RESEARCH ON EDUCATION AND PSYCHOLOGY (REP)

Received: November 9, 2020
Accepted: December 15, 2020
http://dergipark.org.tr/rep

e-ISSN: 2602-3733

December 2020 ◆ 4(2) ◆ 208-221

Research Article

Pedagogical Formation Students' Science-Pseudoscience Beliefs

Menşure Alkış Küçükaydın[1]

Necmettin Erbakan University

Abstract

The concept of pseudoscience is generally defined as claims offered for scientific views but lack any supportive evidence or are hardly reasonable. Although it is necessary to examine the science-pseudoscience beliefs of all individuals in general terms, it is seen that the teacher candidates are included as participants in the studies carried on in Turkey with respect to the distinction between science and pseudoscience. Yet, the pseudoscience beliefs of pedagogical formation students having the potential to become a teacher in the future should be examined as well. From this point of view, this paper aims at determining the beliefs of formation students on distinction between science and pseudoscience. Mixed method has been preferred in the paper. The participants cover a group of 107 individuals who continue their education of formation at a state university of Turkey. The data have been collected from the participants through open-ended questions and using the "Science-Pseudoscience Distinction Scale". Descriptive and statistical analyses as well as content analysis have been applied on the relevant data. The relevant analysis results have indicated that pseudoscience beliefs of the formation students are high. It has been suggested at the end of the study to perform implementations of discussed science activities with the formation of students.

Key Words

Pedagogical formation • Pseudoscience • Science

[1] **Correspondance to:** Assoc., Prof., Necmettin Erbakan University, Ereğli Faculty of Education, Konya, Turkey. E-mail: mensurealkis@hotmail.com **ORCID:** 0000-0003-4410-1279
Citation: Alkış Küçükaydın, M. (2020). Pedagogical formation students' science-pseudoscience beliefs. *Research on Education and Psychology (REP), 4*(2), 208-221.

Exposure of individuals to too many pieces of information in daily life and fast consummation of the information accessed reduce the individuals' appetite for questioning reliability of the information. Failure of individuals to question the source of information accessed from time to time could lead to undesirable conditions as well. The Ministry of Culture and Tourism has compiled the common superstitions in Turkey on its website and indicated that many of such beliefs has no concern with science, reason, modernity and religious belief. It has further been underlined that such beliefs could not be eradicated in mankind's heart, brain or conscience. On the other hand, Topuz's (2012) research conducted with university students suggests that the proportion of faithfulness of particularly girl students to incantation, astrology, psychic power and classical (non-religious) paranormal beliefs named as superstition is high. It has been suggested in the studies carried on abroad that large groups believed in fake science, superstition, lucky numbers and paranormal events including telepathy in the western society as well (Preece & Baxter, 2000). It has been suggested in the study conducted by Kallery (2001) with preschool education teachers that the teachers recognized both astrology and astronomy as science and made no discrimination between science and pseudoscience. It has been detected in the study conducted by Sjödin (1995, as cited in Lundström & Jakobsson, 2009) with high school students that the students adopted certain thought structures including reincarnation, spirit reading or moving objects like telekinesis. Unlike such thought structures; there is a majority of people who admit the effects of science on human life and welfare. The Ministry of National Education (MoNE, 2018) opted for a program change stipulating to educate all individuals as science readers and writers as of the academic year of 2004-2005, with a vision that will reveal scientific thinking. Through the teaching programs renewed in 2018; it has been emphasized on creation of models and products by the students, design of project, promotion of products, expressing themselves verbally, visually and in writing and looking through problems with an interdisciplinary point of view. Consequently, the young generations to be educated are expected to understand science, to believe in importance of science and to overcome with many problems through scientific methods.

Sagan (1995) regards science as a candle that enlightens the dark and states that individuals could have the skill of critical thinking through scientific methods. Science consisting of systematic knowledge sets searches the answers of the questions in the physical universe and serves for freeing research and researchers of prejudices and patterns through peculiar methods and techniques (Beyerstein, 1996). Popper (1963) states that science begins with questions whereas Çepni (2019) remarked diversity, newness and sorting out as the characteristics of science. Özgelen (2013), on the other hand, defined the elements making up science as knowledge, scientific process skills and nature of science. According to the nature of science, scientific knowledge could change and be falsified, the existing theories could be destroyed, scientific knowledge is based on evidences and scientific knowledge is open to innovations (Lederman, 2007). The nature of science has been regarded as the whole of epistemology of science, method of obtaining knowledge and the values and beliefs in development of scientific knowledge (Abd-El-Khalick et al., 1998). Consequently the condition referred to as science and nature of science makes one conclude that scientific knowledge could change by time, there is no single way of performing science, that science took material as basis and science and technology mutually influence each other (McComas et al., 1998). Lack of such characteristics defining science exposes it to the risk of pseudoscience.

The concept of pseudoscience is generally defined as claims which are offered for scientific opinions but which lack supportive evidence or are far from being reasonable (Shermer, 1997). Such claims essentially lack a paradigm or argument, knowledge cannot be developed, consequently knowledge cannot be explained

sufficiently (Afonso & Gilbert, 2010). It is suggested that the concept of pseudoscience is sometimes confused with the concept of non-science because of such characteristics of pseudoscience. Indeed, the concept named as non-science is such contents the ontological and epistemological assumptions of which are different from those of natural sciences, which have different subjects and concepts and consequently which do not claim to be scientific. However the concept of pseudoscience generally covers the contents which claim to be scientific though it fails to respond the criteria of being scientific (Es & Turgut, 2018). Derksen (1993) made definitions that could refer to pseudoscience in his item titled "the seven sins of pseudo-science". Accordingly, pseudoscience persons contribute to production of pseudoscience as well, experimental data are reflected all the time as truths in pseudoscience, one generally disregards the fact that pseudoscience data are wrong, what makes the basis for people to believe in pseudoscience is their tendency to believe in miracles, sometimes pseudoscience makes use of official methods, pseudoscience theories are not verified completely and pseudoscience persons make extreme claims.

The distinction between science and pseudoscience cannot usually be made with clear borders because whether any knowledge is scientific or not may sometimes be related to continuity of knowledge. Jones (2002) explains this with the example of acupuncture therapy because while the spinule therapy performed to stimulate certain spots under the skin was regarded once as pseudoscience, this practice performed with careful controls today is scientifically recognized though limitedly. Although the distinction line between science and pseudoscience cannot be clearly drawn in certain cases, there certain evidences indicating that any knowledge is pseudoscience. Those evidences were summarized by Afonso and Gilbert (2010) as failure to offer confirmative evidences, relying on a single theory or failure to extend the current theory, failure to perform control works and insufficiency of the language used for determining the relevant phenomena. Allchin (1996), on the other hand, mentioned that the opinions derived from the latest current studies carried on and certain psychological factors could change the science-pseudoscience consideration. Consequently it is actually difficult to make distinction between science and pseudoscience contrary to what is supposed. Those difficulties have made it required to discuss on how to decide about the distinction between science and pseudoscience. Smith and Scharmann (1999) suggested to ask the question of "what are the characteristics which make an issue discussed more scientific or less scientific" as the basic question in the discussions to be held in this regard rather than asking the question of "is the issue discussed scientific or not?". Consequently this perspective offered by Smith and Scharmann focuses on the characteristics qualifying science rather than drawing the boundaries between science and pseudoscience.

Although examination of all individuals' science-pseudoscience beliefs is required in general, it is suggested that teacher candidates involved with the programs of natural sciences and classroom teaching are included as participants in the studies carried on in Turkey with respect to distinction between science and pseudoscience. Different results have been obtained in those studies carried on with different groups. While it is suggested in the study conducted by Ayvacı and Bağ (2016) with classroom teachers that the candidates' pseudoscience beliefs are insufficient and that they are sufficiently equipped with scientific knowledge; it has been seen research that Turgut et al. (2016) study preschool teacher candidates that the teacher candidates had difficulty in making the distinction between science and pseudoscience and that they failed to determine the criteria of being scientific. The effects of an intervention program covering scientific criteria on the opinions of the candidates about science and the nature of science were examined in another study conducted with classroom teacher candidates. The

results obtained indicated that the intervention program applied to the candidates has been effective in defeating the pseudoscientific knowledge claims (Es & Turgut, 2018). The relation between the scientist images of the candidates and their science-pseudoscience beliefs was examined in the study conducted by Camci-Erdogan (2019) with classroom teacher candidates. The results obtained indicated that the candidates had stereotypical perceptions about scientists and it was observed that the candidates who received course of scientific research methods had lower pseudoscience beliefs. This study conducted indicated that the course of scientific research methods offered to the candidates was effective and it was concluded that those candidates were more successful in distinction between science and pseudoscience as well. On the other hand, in another study conducted with classroom teacher candidates on pseudoscience, it was suggested that vast majority of the teacher candidates who participated in the study believed in good luck and dream interpretations, half of them believed in horoscopes and again the vast majority regarded astrology as a branch of science (Şenler & İrven, 2016). In the study conducted with natural science teachers for the purpose of revealing the perceptions on distinction between science and pseudoscience; it was suggested that the candidates were at naïve level with respect to accuracy of knowledge, that they generally restricted content of science with experimentally and proof and that they were insufficient with respect to the distinction between science and pseudoscience (Turgut, 2009). It was also suggested in the study conducted with natural science teachers by Uçar and Şahin (2018) that the candidates were insufficient with respect to distinction between science and pseudoscience.

It has been found out that limited number of studies had been conducted on distinction between science and pseudoscience according to the studies accessed in the relevant literature and the studies conducted with teacher candidates. Nevertheless only the graduates of faculty of education could be employed as teachers in Turkey. The bachelors who received education in different fields have the opportunity to be employed as teachers after education of pedagogical formation of approximately one year, offered to them. However it is still unknown what the thought structures of those students who receive pedagogical formation different from or similar to the students of faculty of education. In the relevant literature, with regard to pedagogical formation students, generally, attitudes towards education or teaching profession (Demircioğlu & Özdemir, 2014; Eraslan & Çakıcı, 2011), self-efficacy beliefs (Bakaç & Özen, 2017; Çocuk, Yokuş, & Tanrıseven, 2015), motivations (Altınkurt, Yılmaz & Erol, 2014), teaching profession competencies (Süral & Sarıtaş, 2015), teaching profession anxiety (Uluyol & Şahin, 2018) or their perspectives on the concepts of teaching, student and school (Özdemir & Erol, 2015) are discussed and analyzed. However, it is not known what these students have their cognition structure or their views on the existence of scientific knowledge or science. Thus, it is seen that this is the first study in terms of the examination of science- pseudo-science beliefs of pedagogical training students in Turkey. From this point, it has been aimed in the relevant study to examine science-pseudoscience beliefs of teacher candidates who were graduated from different undergraduate programs and currently continue with their education of pedagogical formation. For this purpose, the study has tried to search for answers to the following sub-problems:

1. What is the level of science-pseudoscience beliefs of the students who receive education of pedagogical formation?

2. What are the opinions of the students who receive education of pedagogical formation on discrimination between science and pseudoscience?

Method

Research Model

Mixed method has been used in this study examining the science-pseudoscience beliefs of the students of pedagogical formation. The mixed method tries to solve the problems not only through quantitative or only through qualitative approaches but using the synthesis of both approaches (Creswell & Clark, 2011). Consequently this study has tried to reveal the science-pseudoscience beliefs of the students of pedagogical formation using both quantitative and qualitative data as well. For this purpose, the scale was used in the quantitative part of the study, and the data are collected using open ended questions in the qualitative part.

Study Group

The study has been conducted with students of pedagogical formation whose science-pseudoscience beliefs had not been discussed before but who have the potential to be the teachers of the future. The students involved in the present study are in the last semester of their education of pedagogical formation which lasts for two semesters. The data were collected from the students studying in a big state university of Turkey in the academic year of 2020-2021. Within this scope, the demographic data of the participants involving in the study are presented in Table 1.

Table 1

Demographic Information

	Age					
Department	20-25	26-31	32-37	37-42	43 ≥	Total
Arabic	28	4	0	0	0	32
Justice	2	3	1	1	2	9
Religious Culture and Ethics	3	2	1	6	5	17
History	12	2	0	0	0	14
Turkish Language and Literature	5	1	3	1	0	10
Philosophy	8	0	2	0	0	10
Child Development and Education	4	1	0	0	0	5
Information Technologies	0	2	0	0	0	2
Mathematic	3	1	2	0	1	7
Accounting	0	1	0	0	0	1
Total	65	17	9	8	8	107

According to Table 1, totally 107 students participated in the study. Students of the department of Arabic constitute a large portion of those students (f=32) whereas it is observed that students of other departments participated less. Furthermore a large portion of the students (f= 65) are within the age group of 20-25 years whereas there are less students in the age groups of 37-42 and 43≥. Additionally, 83 female and 24 male participants participated in the study.

Data Collection Tools

Science-Pseudoscience Distinction Scale. Data collection tool is the "Science-Pseudoscience Distinction Scale" developed by Oothoudt (2008) and adapted to Turkish by Kirman Çetinkaya et al. (2013). 5-point Likert-type scale consists of four factors: Knowledge levels of pseudoscience (KLP), knowledge levels of the scientific process (KLSP), demarcating between science and pseudoscience (DBSP), pseudoscientific beliefs (PB). There

are seven items in the factor of the scale named KLP, seven items in the factor of KLSP, six items in the factor of DBSP and three items in the factor of PB. 1., 3., 7., 9., 11., 16., 18., 21., 22., and 23. items of the scale are reverse coded. The reliability of the scale was calculated by the adapters to be .75. The Cronbach Alpha value of the scale was found to be .92 in this study.

Open Ended Question Form. The other data collection tool used in the study is open ended question form. This form covers the subjects of natural stones considered to qualify pseudoscience and what scientific knowledge is. A careful process of literature review was carried on before the relevant questions are prepared and then expert opinion was referred to. Accordingly, assistance of an expert conducting studies in qualitative field and an expert who has conducted studies on pseudoscience was received and the questions were given their final forms. The relevant questions were applied to two students studying at bachelor's level in the faculty of education before being applied to the study group and understandability of the questions was examined.

After giving the interview form its final form it was applied online using Google forms. Also, written permission was granted from the Ethical Committee of Bartın University (Protocol number. 2020-SBB-0228).

Analysis of Data

The data obtained from the quantitative part of the study were analyzed with SPSS 18.0 program. Normality test of the data transferred to the program was performed and then descriptive and statistical analyses were started. The point value corresponding to each interval of 5-point scale (I definitely disagree, I disagree, I'm indecisive, I agree, I definitely agree) were calculated for the scale used within this scope. However the scoring of Ayvacı and Bağ (2016) was used to determine pseudoscience belief levels of students. Accordingly, the point intervals were determined as 5.0 – 4.3 for "very high", 4.2 – 3.5 for "high", 3.4 – 2.7 for "I have no idea", 2.6 – 1.9 for "low" and 1.8 – 1.0 for "very low" and the assessment was performed accordingly. Independent samples t-test was applied in the study in addition to the descriptive and statistical analyses.

Content analysis has been used for the qualitative data of the study. Within this scope, the data obtained from the students have been coded and themes have created. However assistance of other researchers was received for the relevant data in this stage and he was asked to code the data. The proportion of harmony of the codes determined by the researchers was calculated in conformity with the formula of Miles and Huberman (1994) in this stage and the proportion of harmony was determined as 100%. An online meeting was held for the codes with dissensus and shared decisions were reached. In this manner, four themes were reached with respect to natural stones and seven themes were reached with respect to the title of scientific knowledge.

Findings

The findings reached from the data obtained within the scope of the study are presented under two titles as quantitative and qualitative findings.

Quantitative Findings on Science-Pseudoscience Discrimination

The scores of the students of pedagogical formation from the science-pseudoscience scale were calculated separately for the scale in general terms and on the basis of the factors. The findings for those values are presented in Table 2.

Table 2

Descriptive Statistics

	N	Number of Items (k)	Min Score	Max Score	Mean	Mean/k	Sd
DBSP	107	6	1.57	4.71	26.53	3.79	.28
KLSP	107	7	1.67	5.00	22.56	3.76	.44
KLP	107	7	2.00	5.00	9.99	3.33	.52
PB	107	3	1.71	4.29	20.58	2.94	.24
Total	107	23	2.43	4.13	79.58	3.46	.32

When Table 2 is examined, it is observed that the item average for the scale in general terms is 3.46. The answers that the students give to the science-pseudoscience scale is within the range of "I have no idea" according to this average. When the answers are examined according to the factors of the scale; it is observed that the students answered "I highly agree" (X=3.79 and X= 3.76) for DBSP and KLSP factor, "I have no idea" (X= 3.33 and X=2.94) for KLP and PB factors. The answers given by the students to the scale are summarized in Table 3 on gender basis.

Table 3

Scores from the Scale by Gender

	Gender	N	X	S	t	Sd	p
DBSP	Female	83	3.75	.54	-1.334	105	.18
	Male	24	3.92	.46			
KLSP	Female	83	3.76	.56	.059	105	.93
	Male	24	3.75	.95			
KLP	Female	83	3.31	.70	-.450	105	.65
	Male	24	3.38	.78			
PB	Female	83	2.92	.48	-.641	105	.52
	Male	24	3.00	.55			
Total	Female	83	3.45	.30	-1.06	105	.30
	Male	24	3.52	.39			

Independent samples t-test was performed to compare the scores of the female and male students' answers to the science-pseudoscience scale in Table 3. There is no meaningful difference between the scores of the female and male students both in the factors of the scale and in the scale in general terms ($p > .05$) according to the results of the test performed. The size of the differences of the averages (mean difference = -.079) are very small. However looking through the size of the difference between the groups ($\eta 2 = 0.48$), the effect is observed to be quite high (Cohen, 1988, p.284). Namely no meaningful difference can be reached for science-pseudoscience consideration in terms of gender whereas it is clearly observed that gender reveals a variance of 48% for science-pseudoscience. Consequently, it is accepted that the size of the sample in the study is quite effective on effect size. However it is deemed necessary to deeply examine those results obtained in the study. Consequently this paper tries to examine qualitative data on the basis of such information obtained.

Qualitative Findings on Science-Pseudoscience Discrimination

This part of the paper presents the analysis of the data reached through a form consisting of open ended questions in order to allow more detailed examination of the qualitative data obtained from the students. The thoughts of the students about what scientific knowledge is and about natural stones were questioned in this form. Firstly, the students were asked whether natural stones are really effective on human health. The answers

received from the students within this scope have been categorized under the titles of "definitely effective", "definitely not effective", "may be effective under certain circumstances" and "I have no idea" (Table 4). The students who give the answer of "definitely true" generally mentioned the issue of creation of the universe and thought that each substance in the world served for a specific purpose and stated that the stones are useful for humanity. The students who do not believe that stones have any effect on human health on the other hand generally defined this situation as superstition. The students who answer in the theme of "may be true" with respect to whether stones have any effect on human health related the effects of stones on human health rather with psychological condition. Accordingly, if a person believes that the stones are useful, he/she could recover and if he/she believes that the stones are not useful he/she will not be healed. Namely the condition of stones providing benefit or not was associated with the individual's belief. Finally some of the students were indecisive and did not express any opinion for this reason. However when their expressions are examined, it is observed that there are also expressions close to "may be true".

Table 4

Effect of Stones on Human Health According to the Students

Theme	f	Sample Expression
Definitely True	32	"I think that natural stones are effective on human health. We regard them as simple stones but I think they are no longer stones when we use them and observe their benefits", "Yes. I believe that stones have extraordinary power", "I think that natural stones are definitely useful. I don't know why but maybe because they are natural stones".
Definitely False	27	"I never believe that natural stones have extraordinary powers like this", "It cannot be proved whether they are true without conducting any scientific research", "Superstition", "It cannot be true. I don't believe in such superstitions. If what they say were true, the world would be a much better place, everybody would use those stones".
May Be True	36	"I think that it may be true, because those stones are composed of specific minerals and I consider that they have different energies and guess that this energy could help with treatment of a disease", "I believe that this is completely psychological. If you believe that you will be well if you carry this stone, you'll be well psychologically", "It may be, I'm convinced that existence of any living or non-living thing in the nature has some purpose and reason".
I Have No Idea	12	"I cannot suggest any opinion about its truth but I need to examine the research conducted on the issue", "Stones are told to have magnetic or other energies. But I don't have any idea about how its effect could be", "I'm indecisive in this regard; maybe because persons believe that it will be good psychologically or they may heal because the substance they contain".

The students were further asked what scientific knowledge is in the form composed of open ended questions. Majority of the students (f = 43) stated that science is definite knowledge accuracy of which is evidenced. Still majority of the students (f = 29) mentioned that scientific knowledge could be achieved through experiment and stated that assumption should exist in order to achieve scientific knowledge (f = 10). However very few students mentioned changeable nature of scientific knowledge (f = 5). Additionally, reliability of knowledge (f= 9),

existence of logical and reasonable knowledge (f = 9), knowledge having cause and effect relation (f=6) was mentioned with respect to scientific knowledge (Table 5).

Table 5

Characteristics of Scientific Knowledge According to Students

Characteristics of Scientific Knowledge	f*
Having changeable structure	5
With accuracy evidenced by scientists and being definite	43
Giving the same result when repeated under the same circumstances	9
Reaching the method of solution on the basis of assumptions	10
Having logical and acceptable knowledge structure	9
Having knowledge structure with cause and effect relation	6
Achieving knowledge through experiments	29

*The number *f* is higher than the number of participants since more than one answer is given.

Discussion

Both quantitative and qualitative data collection tools were used in this paper examining science-pseudoscience beliefs of students of pedagogical formation and certain results were obtained. Quantitative data indicated that the answers of the students to the pseudoscience scale applied to them remained at the level of "I have no idea". Those results obtained resemble the results obtained in the study of Camci-Erdogan (2019). Nevertheless the results obtained in the relevant study indicated that the course of scientific research methods have effect on pseudoscience beliefs. Consequently one can say that the course of scientific research methods have effect on the students' points of view with respect to science, working method of scientists and achieving scientific knowledge. It is observed that explaining the developments related to history of science in the literature and mentioning the working methods of science are effective on beliefs about scientific knowledge (Alkış Küçükaydın & Gökbulut, 2020). In the study conducted by Es and Turgut (2018) with classroom teacher candidates, the candidates were given research works on astrology, reflexology, healing stones, acupuncture, ufology, graphology, parapsychology and iridology for one week for each and they were asked to assess the knowledge in those fields in the context of science-pseudoscience. The candidates participating in the study have been observed to have created pseudoscience awareness. The results obtained from the present study and the findings indicated in the relevant literature indicate that one should particularly dwell on pseudoscience beliefs.

When the data collected within the scope of the study were examined in terms of gender, it was found out that there is no statistically meaningfulness in the scores achieved for female and male students. However when the total score is examined on gender basis, it was found out that the effect size is quite high. This indicates that this study should essentially be performed on a bigger sample. Consequently more comprehensive data could be achieved in studies to be performed on a bigger sample.

The students were asked open ended questions for the purpose of achieving more detailed results apart from the quantitative data achieved in the study. The results obtained indicated that students generally could not make distinction between science and pseudoscience. It has been observed in the study conducted by Afonso and Gilbert (2010) on groundwater identification that the participants generally had insufficient level of scientific knowledge. This means that the students are vulnerable to pseudoscience. According to Afonso and Gilbert, vulnerability of students to pseudoscience arises from their insufficient comprehension about nature of scientific

knowledge. Similarly, the studies conducted by Ayvacı and Bağ (2016), Kallery (2001) with teacher candidates and tutors of teachers suggested that pseudoscientific beliefs were strong. It was suggested in the study by Lundström and Jakobsson (2009) where they examined pseudoscientific beliefs related to human body that students think the lunar phases have an effect on human health and female and male students have different pseudoscientific beliefs. Another remarkable finding in the study is that any student successful in natural science classes trusts pseudoscientific knowledge as well at the same time. This indicates that teaching critical thinking skills is important even when natural sciences are taught at schools. At that point, the relevant literature suggests that it is necessary to focus on detailed learning rather than superficial learning in science teaching and to make students comprehend the distinctions among theorem, proposal or hypothesis (Martin, 1994). Turgut (2009) on the other hand stated in this regard that the classroom discussions through contextual relations including astronomy-astrology.

When the students' answers to the question of what scientific knowledge is are examined; it has been detected that very few students underlined changeable nature of scientific knowledge and consequently many students told that the it is the knowledge confirmed by scientists and definite knowledge. Still, majority of the students accepted scientific knowledge as knowledge achieved through experimental ways. Although similar results were achieved in the relevant literature (Turgut, 2009). Also Turgut et al. (2016) reported in the study conducted with preschool teacher candidates that the candidates rather associated scientific knowledge with experiment and observation and rejected the idea that science is a method of knowing. Afonso and Gilbert (2010) underlined that students failed to develop a critical point of view toward pseudoscience if they are insufficient in terms of scientific knowledge. Insufficient level of students with respect to scientific knowledge, particularly the idea that scientific knowledge could only be achieved through experiment indicates that they have traditional science belief. According to Beyerstein (1996), distance of individuals to scientific literacy prompts them to pseudoscience. For this reason, it is necessary for the society to take serious decisions on extending science literacy. As a matter of fact Şenler and İrven (2016) suggested in their study with classroom teacher candidates that pseudoscience belief of the students who participate in the courses of history of science and nature of science is lower compared to the other classes. Consequently it is observed that the education offered to teacher candidates contribute to development of scientific opinion.

Limitations and Recommendations

The paper conducted with students of pedagogical formation has certain restrictions. Firstly, data were collected over a quite small sample within the scope of this paper. This may be regarded as a potential danger for the study at the same time. For this reason, the researchers who will conduct studies on this subject are recommended to reach students of formation within the whole country and to theoretically examine the effect size obtained within the scope of this study. Furthermore the students are asked open ended questions using an online form within the scope of the study. This study where face-to-face interviews cannot be held because of Covid-19 pandemic could be repeated with focus group meetings. This may allow examining the restricted information obtained through open ended questions in more detail. Additionally, it has been observed that students of formation had high pseudoscience belief within the context of the paper. This is regarded as a risk for the students of the teachers of the future. The relevant literature indicates that belief of students in scientific knowledge is observed to be increased through scientific research methods and history of science. It is deemed

necessary on this basis for students of formation to include such a course in the curriculum or to involve the content of learning critical science in the contents of other courses in the recent period.

Ethics Approval

I declare that the research was conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Also, written permission was granted from the Ethical Committee of Bartın University (November 2020 date and Protocol number. 2020-SBB-0228).

References

Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82*(4), 417-436.

Afonso, A.S., & Gilbert, J.K. (2010). Pseudo-science: A meaningful context for assessing nature of science. *International Journal of Science Education, 32*(3), 329-348.

Alkış Küçükaydın, M., & Gökbulut, Y. (2020). Beliefs of teacher candidates toward science teaching. *Journal of Science Teacher Education, 31*(2), 134-150.

Allchin, D. (1996). Points east and west: Acupuncture and comparative philosophy of science. *Philosophy of Science, 63,* 107–115.

Altınkurt, Y., Yılmaz, K., & Erol, E. (2014). Pedagojik formasyon programı öğrencilerinin öğretmenlik mesleğine yönelik motivasyonları [Pedagogic formation program students' motivations for teaching profession]. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 4*(1), 48-62.

Ayvacı, H. Ş., & Bağ, H. (2016). Sınıf öğretmeni adaylarının bilim sözde-bilim ayrımına ilişkin görüşlerinin incelenmesi [Examination of elementary teacher candidates' views on pseudoscience distinction]. *Amasya Education Journal, 5*(2), 539-566.

Bakaç, E., & Özen, R. (2017). Pedagojik formasyon öğrencilerinin öğretmenlik mesleğine yönelik öz-yeterlik inançları ile tutumları arasındaki ilişki [Relationship between pedagocical certificate program students' attitudes and self-efficacy beliefs towards teacher profession]. *Kastamonu Education Jounal, 25*(4), 1389-1404.

Beyerstein, B. L. (1996). *Distinguishing science from pseudoscience*. Department of Psychology, Simon Fraser University. Prepared for The Centre for Curriculum and Professional Development, Victoria, B.C., Canada. Downloaded 13. 10. 2020 from https://www.dcscience.net/beyerstein_science_vs_pseudoscience.pdf

Camci-Erdogan, S. (2019). How do prospective elementary and gifted education teachers perceive scientists and distinguish science from pseudoscience? *Journal of Education in Science, Environment and Health, 5*(1), 119-133.

Cohen, J.W. (1988). *Statistical power analysis for the behavioral sciences* (2nd). Hillsdale, NJ: Lawrence Erlbaum Associates.

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and conducting mixed methods research*. London: Sage Publications.

Çepni, S. (2019). Kuramdan uygulamaya fen ve teknoloji öğretimi[Science and technology teaching from theory to practice]. S. Çepni (Ed). In *Bilim, fen, teknoloji kavramlarının eğitim programlarına yansımaları [Reflections of science, science and technology concepts on educational programs]* (pp.2-12). Ankara: Pegem Akademi.

Çocuk, H. E., Yokuş, G., & Tanrıseven, I. (2015). Pedagogical formation students' self-efficacy and metaphoric perceptions related to teaching profession. *Mustafa Kemal University Journal of Graduate School of Social Sciences, 12*(32), 373-387.

Demircioğlu, E., & Özdemir, M. (2014). Pedagojik formasyon öğrencilerinin çok kültürlü eğitime yönelik tutumlarının bazı değişkenlere göre incelenmesi [Analysis of pedagogical formation students' attitudes toward multicultural education]. *Ege Eğitim Dergisi*, *15*(1), 211-232.

Derksen, A. A. (1993). The seven sins of pseudo-science. *Journal for General Philosophy of Science*, *24*(1), 17-42.

Eraslan, L., & Çakıcı, D. (2011). Pedagojik formasyon programı öğrencilerinin öğretmenlik mesleğine yönelik tutumları [Pedagogical formation program students' attitudes towards teaching profession]. *Kastamonu Education Journal, 19*(2), 427-438.

Es, H. & Turgut, H. (2018). Candidate classroom teachers' perceptions about being scientific in the context of pseudoscience. *Journal of Education in Science, Environment and Health, 4*(2), 142-154.

Jones, J. P. (2002). Ultrasonic acupuncture and the correlation between acupuncture stimulation and the activation of associated brain cortices using functional magnetic resonance imaging. *Bulletin of Science, Technology & Society*, *22*, 362–370.

Kallery, M. (2001). Early-years educators' attitudes to science and pseudoscience: The case of astronomy and astrology. *European Journal of Teacher Education, 24*(3), 329-342.

Kirman Çetinkaya, E., Laçin Şimşek, C., & Çalışkan, H. (2013). Bilim ve sözde-bilim ayrımı için bir ölçek uyarlama çalışması [The adaptation study of science and pseudoscience distinction]. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 3*(2), 31-43.

Lederman, N.G. (2007). Nature of science: Past, present, and future. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp. 831–879). Mahwah, NJ: Lawrence Erlbaum Associates.

Lundström, M., & Jakobsson, A. (2009). Students' ideas regarding science and pseudo-science in relation to the human body and health. *Nordic Studies in Science Education*, *5*(1), 3-17.

Martin, M. (1994). Pseudoscience, the paranormal, and science education. *Science & Education*, *3*(4), 357-371.

McComas, W. F., Clough, M. P., & Almazroa, H. (1998). The role and character of the nature of science in science education. In *The nature of science in science education* (pp. 3-39). Dordrecht: Springer.

Miles, M, B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. (2nd ed). Thousand Oaks, CA: Sage.

Ministry of National Education [MoNE] (2018). *Fen bilimleri dersi öğretim programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar)* [Science course curriculum (Primary and secondary school 3, 4, 5, 6, 7 and 8th grades)] Ankara: Millî Eğitim Bakanlığı Temel Eğitim Genel Müdürlüğü.

Oothoudt, B. (2008). *Development of an instrument to measure understanding of the nature of science as a process of inquiry in comparison to pseudoscience*. Master Dissertation. Long Beach: California State University, Department of Science Education.

Özdemir, T. Y., & Erol, Y.C. (2015). Pedagojik formasyon eğitimi alan öğretmen adaylarının okul, öğretmenlik ve öğrenci kavramlarına ilişkin algıları [The perceptions of prospective teachers having pedagogic formation

education about the notions of school, teaching and student]. *Celal Bayar University Journal of Social Sciences*, *13*(4), 215-244.

Özgelen, S.(2013). Development of nature of science scale. *Journal of Kastamonu Faculty of Education, 21*(2), 711-736.

Popper, K. R. (1963). Science as falsification. *Conjectures and Refutations, 1*, 33-39.

Preece, P. F. W., & Baxter, J. H. (2000). Scepticism and gullibility: The superstitious and pseudoscientific beliefs of secondary school. *International Journal of Science Education, 22*(11), 1147-1156.

Sagan, C. (1995). *The demon-haunted world: Science as a candle in the dark*. New York, NY: Random House.

Shermer, M. (1997). *Why people believe weird things: Pseudoscience, superstition, and other confusions of our time.* New York, NY: W. H. Freeman and Company.

Smith, M. U., & Scharman, L. C. (1999). Defining versus describing the nature of science: A pragmatic analysis for classroom teachers and science educators. *Science Education, 83*(4), 493-509.

Süral, S., & Sarıtaş, E. (2015). Pedagojik formasyon programına katılan öğrencilerin öğretmenlik mesleğine yönelik yeterliklerinin incelenmesi [The investigation of the students of pedagogical formation the towards teaching profession qualifications]. *Mersin University Journal of the Faculty of Education*, *11*(1), 62-75.

Şenler, B., & İrven, Ö. (2016). Sınıf öğretmeni adaylarının epistemolojik inançları ile sözde-bilimsel inançları [Primary pre-service teachers' epistemological beliefs and pseudoscientific beliefs]. *Mersin University Journal of the Faculty of Education*, *12*(2), 659-671.

Topuz, İ., (2012). Gençlerde normatif, popüler ve paranormal inançlar üzerine bir araştırma: SDÜ örneği [A research on normative, popular and paranormal beliefs in youth: SDU example]. *Review of the Faculty of Divinity University of Süleyman Demirel*, 29, 13-40.

Turgut, H. (2009). Pre-service science teachers' perceptions about demarcation of science from pseudoscience. *Education and Science*, *34*(154), 50-68.

Turgut, H., Eş, H., Bozkurt Altan, E., & Öztürk Geren, N. (2016). Pre-service pre-school teachers' perceptions of science and pseudoscience. *International Online Journal of Educational Sciences, 8*(1), 150-169.

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

Uluyol, Ç., & Şahin, S. (2018). Pedagojik formasyon öğrencilerinin öğretmen kimliği ve mesleki kaygı durumlarının incelenmesi [Investigation of pedagogical formation students' teaching identity and professional loss conditions]. *Turkish Journal of Social Research*, *22*(4), 1051-1071.