Pedagogical Research
2025, 10(1), em0228
e-ISSN: 2468-4929
https://www.pedagogicalresearch.com

MODESTUM

Research Article

OPEN ACCESS

Examination of prospective teachers' views, attitudes, and practices towards the history and philosophy of science course

Ebru Şipşak [1], Ezgi Taylan Koparan [2], Timur Koparan [2*]

[1] Ministry of National Education, Ankara, TÜRKİYE
[2] Department of Mathematics and Science Education, Eregli Faculty of Education, Zonguldak Bülent Ecevit University, Zonguldak, TÜRKİYE
***Corresponding Author:** timurkoparan@gmail.com

Citation: Şipşak, E., Taylan Koparan, E., & Koparan, T. (2025). Examination of prospective teachers' views, attitudes, and practices towards the history and philosophy of science course. *Pedagogical Research, 10*(1), em0228. https://doi.org/10.29333/pr/15589

ARTICLE INFO

Received: 08 May 2024

Accepted: 14 Oct. 2024

ABSTRACT

The history and philosophy of science course is among the very important courses for prospective teachers in terms of understanding the development of science, evaluating its social and cultural context, developing scientific thinking skills, and better understanding and teaching scientific knowledge. Studies on this subject are important in terms of teaching planning and development. This research aimed to examine prospective teachers' opinions, attitudes and practices towards the history and philosophy of science course. The study group, conducted within the scope of a special case study, consists of 54 prospective teachers studying at a state university in different programs in the 2020-2021 academic year. An opinion form prepared by taking expert opinions, the history of science attitude scale and lesson plans prepared by prospective teachers were used as data collection tools. Additionally, semi-structured interviews were conducted and recorded with six prospective teachers. The data obtained from the opinion form, interviews and lesson plans were analyzed qualitatively and codes, categories and themes were created. The findings obtained were interpreted and supported by direct quotations. The data obtained from the attitude scale was analyzed with the SPSS program. The findings revealed that the attitudes towards the history and philosophy of science course were generally positive, the course content was sufficient, and the prospective teachers found the course fun, interesting, intriguing, and very useful in terms of questioning and developing different perspectives. In line with the results obtained, suggestions were made to educators and researchers.

Keywords: prospective teachers, history of science, philosophy of science, attitude

INTRODUCTION

History of science examines the development process of science. In other words, the history of science can be called the story of the beginning and development of science. While telling this story, not only history but also many disciplines are used (Şimşek, 2011). How has the information arrived so far? What efforts did scientists make? What tools and methods did he use? What was the fundamental force on which science was based? The history of science sheds light on the answers to these and similar questions and reminds us of the value and importance of knowledge (Topdemir & Unat, 2008).

Conducting scientific studies and advancing science and technology can only be achieved through scientifically literate individuals with lifelong learning skills (Çolakoğlu, 2002). It is important to access scientific information in order to understand the universe and its functioning, to question how and for what purpose this information can be used, and to raise scientifically literate individuals in order to use science as a guide in the development of society (Çepni et al., 1997). Being in such a state of development and change; The ultimate goals of education programs are to raise individuals who are open to change in order to adapt to science and technology, develop an innovative perspective, put their thoughts into practice and fulfill the requirements of the age. In order to raise individuals with these qualifications, the history of science should be included in the curriculum (Çelik, 2019). There is a need for a curriculum that includes this purpose, as well as individuals who have certain thinking skills that include science and technology (Hurd, 1998). In courses where the historical and human dimensions of science are presented by emphasizing, historical problems can inspire students about the ways of thinking of scientists, the solution processes of problems, the discussions held, and the concepts that emerge. Thus, students' approaches to lessons and science can be positively affected (Allchin, 2013).

This article was a part of the master thesis of the first author, which was supervised by the second author.

Table 1. Participants and their participation in data collection tools

Program	Class	The number of participants	Gender	Attitude scale	Lesson plan	Interview
Science	2-3	18	14F & 4M	13	18	S5 (F)
Mathematics	2-3	12	6F & 6M	17	12	M21(F)
Psychological counseling and guidance	2	13	9F & 4M	9	13	PCG36 (F)
Pre-school	3	4	2F & 2M	5	4	PS44(M)
Social studies	2-3	6	3F & 3M	3	6	SS50 (F)
Turkish	3	1	1M	1	1	T54(M)
Total	6	54	54	48	54	6

Note. M: Male & F: Female

The reflection of the history of science on science education curricula has been seen in the curricula of many countries, and its impact on studies on this subject has been emphasized (Adúriz-Bravo & Izquierdo-Aymerich, 2004). Since the 1960s, history and philosophy of science courses have been included in education faculties in order to improve teachers' and prospective teachers' perspectives on science (Özdemir & Akçay, 2009). In our country, the history of science started to be included in the undergraduate programs of the faculties of education in 2006, and it is seen that the program demands from us in order to be able to use the history of science in the curriculum, what science is, how it progresses, and its relationship with individuals, into the classroom context (MEB, 2013). As it can be concluded from here, learning the history of science and being able to apply it has an important place in our lives and affects the perspective towards science positively. In addition to being a new field for teachers, the history of science is seen in research as an additional source that includes short stories used for conceptual goals (Hacieminoğlu et al., 2012; İrez et al., 2011; Narguizian, 2002; Şimşek, 2011; Wang, 1998; Wang & Cox-Petersan, 2002). From this perspective, there is an important responsibility for prospective teachers and teachers who will use and shape the history of science according to teaching techniques and methods based on the curriculum. The history and philosophy of science course, which sheds light and guides the development of science, has been included in the curriculum of universities, and it is of great importance for future prospective teachers to work on it in order to teach it better and make it more permanent (Şimşek, 2011).

Considering the above explanations, the history and philosophy of science course is included as an elective course in the higher education program. The history of science course, which guides the development of science, has an important position in the professional lives of university students. Uncovering the opinions of university students about this course is important in terms of more effective planning and maintenance of the course. Therefore, there is a need to reveal the attitudes and practices of university students towards this course.

Aim and Research Problem

This research aims to examine the attitudes, opinions and practices of prospective teachers towards the history of science. The research problem is: What are the opinions, attitudes and practices of prospective teachers towards the history and philosophy of science course? It was determined as.

1. Is there a significant difference between the attitudes of prospective teachers before and after the history and philosophy of science course?
2. Do prospective teachers' attitudes towards the history and philosophy of science course differ according to gender?
3. What are the opinions of prospective teachers about the history and philosophy of science course?
4. What are the practices of prospective teachers towards the history and philosophy of science?

METHOD

In this research, the case study method was used. Case studies are used to seek answers to scientific questions. This method enables in-depth examination and research of one or more events, situations or social communities (McMillan, 2000). Multiple data sources such as interviews, observations and document analysis can be used in a special case study. Thus, while an event or phenomenon is conveyed in its entirety within itself, clear boundaries are not drawn (Yıldırım & Şimşek, 2008). According to Yin (1984), a case study is a research method that reflects a phenomenon in its holistic reality and uses multiple data sources, where the line between the phenomenon and the content is not clearly separated. In this method, the researcher can focus deeply on the subject and examine the causes and effects (Çepni, 2001). In this research, different data collection tools (survey, interview, document analysis) were used, both qualitative and quantitative, and the focus was on the opinions, attitudes and practices of prospective teachers towards the history and philosophy of science course. It was thought to be a method.

Working Group

The study group of the research consists of prospective teachers taking the history and philosophy of science course in the 2020-2021 academic year at a state university in the Western Black Sea Region. 54 prospective teachers from six undergraduate programs (mathematics, science, social studies, Turkish, preschool, psychological counseling and guidance) participated in the study, and 48 of these participants completed the attitude scale. Additionally, semi-structured interviews were conducted with 6 prospective teachers. Participants were coded as S5, M21, PCG36, PS44, S50, and T54. Participants and their participation in data collection tools are presented in **Table 1**.

Table 2. History and philosophy of science course content

Week	Content
1	Basic problems of history and philosophy of science, science, philosophy and scientific method, historical development of sciences and philosophy
2	Science in ancient times, science in Egypt and Mesopotamia, science in China and India.
3	Science and philosophy in Ancient Greece (Hellenic Period)
4	Science and philosophy in the Greek Period (Hellenistic Period)
5	Science in Roman times
6	Science and philosophy in the Middle Ages (in the Christian world)
7	Science and philosophy in the Middle Ages (in the Islamic world)
8	Turks' entry into Islam and scientific activities in this period
9	Midterm
10	Science during the Renaissance
11	Science in modern times (science in the 17th and 18th centuries)
12	Science in modern times (science in the 17th and 18th centuries)
13	Science in the modern era (19th and 20th centuries)
14	Science in the modern era (19th and 20th centuries)

Data Collection Tools and Data Analysis

In this research, the "history of science attitude scale" (Alışır et al., 2020) was used to determine the attitudes of prospective teachers towards the history and philosophy of science course. This scale was developed by three researchers in order to reveal the attitudes of prospective teachers towards the history of science and their use of history of science in their lessons. While developing the scale, expert opinion was sought to ensure the content validity of the items in the item pool. Exploratory and confirmatory factor analysis was conducted for the construct validity of the scale. Cronbach's alpha internal consistency coefficient for the reliability of the scale was calculated as 0.95. The "history of science attitude scale" developed by Alışır et al. (2020) consists of a total of 29 items, 24 of which are positive and 5 of which are negative. This scale, in which prospective teachers are asked to express their thoughts about the history of science course they have taken, and the application carried out in this course, is a 5-point Likert type such as "completely agree", "very much agree", "moderately agree", "somewhat agree" and "strongly disagree". The second data collection tool used in the research is the "Opinion form for the history and philosophy of science course". It was prepared by the researcher in order to reveal the opinions of prospective teachers about the relevant course. Expert opinion was taken while preparing the opinion form consisting of 13 open-ended questions. The third data collection tool is the lesson plans prepared by prospective teachers in their own branches according to the 5E lesson model. In these lesson plans, prospective teachers were asked to integrate the history of science into their lesson plans.

"History of science attitude scale" was applied as pre-test and post-test to the prospective teachers participating in the research. The obtained data were transferred to the computer environment and analyzed with the SPSS program. A dependent sample t-test was conducted to determine whether there was a significant difference between the pre-test and post-test scores. In addition, an independent sample t-test was applied to the pre-test and post-test scores to determine whether the attitudes of prospective teachers towards the history and philosophy of science course differed by gender. The aim of the research was to collect more detailed information through interviews with six prospective teachers. Interviews lasted approximately seven to eight minutes and were audio and video recorded. It was later transcribed. The qualitative data obtained was subjected to content analysis. were categorized, frequency was calculated and interpreted. Content analysis aims to understand and interpret an expression by eliminating special factors and to create objective comments against the explanations made regarding the reader's perception, attitude and knowledge (Bilgin, 2014). In this regard, in the study, first of all, the opinions of the prospective teachers were coded, and after ensuring the accuracy of the coding, categories were created. After these categories were created, a transition was made to themes. Similar points in the qualitative data of the study were also interpreted under a single theme. The findings obtained are presented with direct quotations from the answers given by the prospective teachers. The lesson plans prepared by the prospective teachers were examined in detail and the stages of the 5E model in which they effectively used the history of science and the methods and techniques they used to integrate the history and philosophy of science into the lessons were determined. The findings obtained from the lesson plans are presented in tables within the framework of the programs in terms of achievement, content and applications categories.

Process

The history and philosophy of science course, which was held for a total of 14 weeks with two lecture hours (theoretical) per week, was conducted by the second researcher. The course content is detailed in **Table 2**. In the 8th week, the researchers informed the prospective teachers about the 5E learning model and its stages and sample lesson plans were presented. Pre-service teachers were asked to prepare a lesson plan in their field according to the 5E learning model and to integrate the history and philosophy of science into these lesson plans. 2 weeks are given for this assignment. In the first and last weeks of the research process, the history of science attitude scale was applied to prospective teachers as pre-test and post-test. After the post-test, semi-structured interviews were held with the prospective teachers. After the data was collected, analyzes started.

Table 3. Findings regarding the normality assumption

	N	Mean	Sum of squares	Median	Skewness	Kurtosis
Pre- test	48	103.3750	13.31872	103.50	-0.237	0.023
Post-test	48	108.8542	11.65458	109.00	-0.118	-0.117

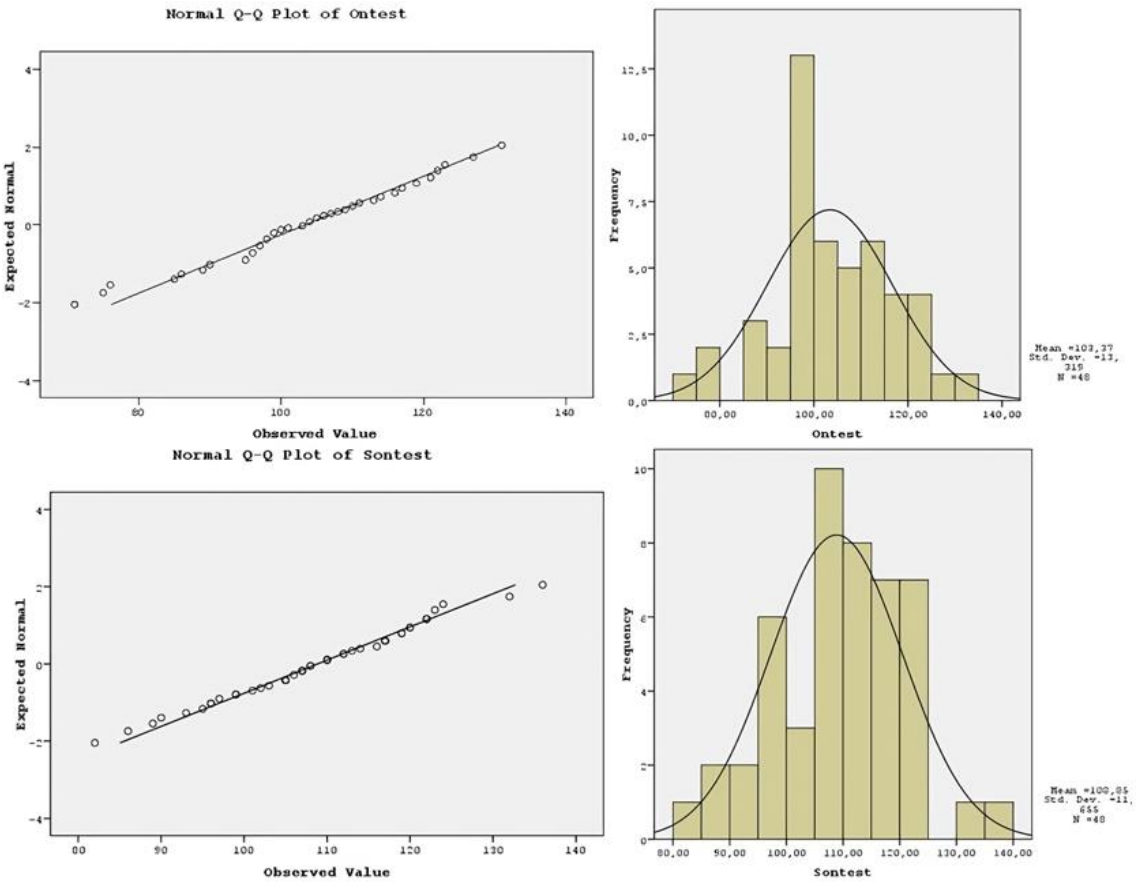

Figure 1. Q-Q and histogram graphs regarding normality (Şipşak, 2023)

Table 4. Dependent t-test results on pre- and post-test attitude scores of prospective teacher

Test	N	Mean	Sum of squares	Standard deviation	t	p
Pre- test	48	103.3750	13.31872	47	-2.909	0.006
Post-test	48	108.8542	11.65458			

RESULTS

The findings obtained from the research are presented under headings in line with the research problems.

Findings Obtained From Prospective Teachers' Attitudes Towards the History and Philosophy of Science Course

First of all, it was examined whether the data provided normal values in order to perform parametric tests. In this process, pre- and post-test normality tests were performed. In order for the data to show normality, if the skewness and kurtosis value is between ± 1.0, it is considered ideal for the purpose; depending on some applications, ± 2.0 may also be accepted. **Table 3** shows the findings regarding the normality assumption.

As seen in **Table 3**, the skewness and kurtosis values of the variables are ± 1.0. This means that the data is normally distributed.

In addition to the statistical tests performed, graphical methods are also used. Q-Q and histogram graph can show whether the test provides normality or not. In Q-Q charts, if the data listed on the coordinate plane and the table values of the standard normal distribution are distributed on a linear line, it is understood that the data exhibits a normal distribution.

As seen in **Figure 1**, it was seen that the Q-Q graphs of the pre-test and post-test showed a distribution on a straight line. This means that the data distribution is normal. According to the findings obtained from the analysis, it was concluded that the data, which is a priority for parametric tests to be performed, provided normality.

A dependent sample t-test was conducted to determine whether there was a significant difference between the attitude scale to be administered before and after the history and philosophy of science course and the data obtained from the pre-test and post-test. The findings obtained are presented in **Table 4**.

Table 5. Pre-test independent t-test results according to gender variable

Gender	N	Mean	Sum of squares	Standard deviation	t	p
Woman	36	104.4444	13.19187	46	-0.963	0.341
Man	12	100.1667	13.75654			

Table 6. Post-test independent t-test results according to gender variable

Gender	N	Mean	Sum of squares	Standard deviation	t	p
Woman	36	108.5000	12.75819	46	0.361	0.720
Man	12	109.9167	7.79812			

Table 7. Opinions of prospective teachers regarding the history and philosophy of science course

Category	Codes	PT
Understanding science	Providing resources for the future/being the building block of society/making life easier/ passing on the path of knowledge/being based on reality/arising from curiosity and need	S5, M21, PCG36, ÖAPS44, SS50, & T54
Change of scientific knowledge	Ability to prove/disprove/attempt to prove/being subjective/based on experiment/prompting research	S5, M21, PCG36, PS44, SS50, & T54
Sources of information in science	Inscriptions/papyrus/clay tablets/monuments/the public web, scientific research/manuscripts/life itself/scientists	S5, M21, PCG36, PS44, SS50, & T54
Enriching teaching with history of science activities	Increasing productivity/ensuring permanence/being interesting/guiding/developing the sense of discovery/effective learning/gaining experience/gaining a holistic perspective	S5, M21, PCG36, PS44, SS50, & T54
Understanding the concept of history of science	Understanding the development process of science/contributing to humanity/being based on a body of scientific facts/being cultured/following the process of knowledge/trying to find knowledge/the process of discovery	S5, M21, PCG36, PS44, SS50, & T54
Meeting history of science course expectations	Desire to learn about science/interest in science/creating a sense of curiosity/assimilating information/ Increasing awareness/making sense of information/gaining a pragmatic perspective/liking science	S5, M21, PCG36, PS44, SS50, & T54
Affective aspect of the history of science course	Adding value to science/being willing/embracing science/creating satisfaction/academic orientation	S5, M21, PCG36, PS44, SS50, & T54

As seen in **Table 4**, the pre-test mean score of the prospective teachers' attitudes towards the history and philosophy of science course was determined, as mean (M) = 103.3750, and the post-test mean score was determined, as M = 108.8542. In the t-test for dependent samples conducted for the pre-test and post-test data, it was seen that there was a statistically significant difference in favor of the post-test between the averages of the attitude scores of the prospective teachers towards the history and philosophy of science course ($t_{(47)} = -2.9090$, $p < 0.05$ [0.006]).

Findings Regarding the Gender Variable

In this section, independent t-tests were conducted for pre-test and post-test to determine whether prospective teachers' attitudes towards the history and philosophy of science course differed by gender. The results obtained are shown in **Table 5**.

As seen in **Table 5**, pre-test attitude and post-test attitude scores of prospective teachers towards the history and philosophy of science course do not show a significant difference according to gender ($t_{(46)} = -0.9630$, $p > 0.05$). In other words, pre-test attitude scores of prospective teachers towards the history and philosophy of science course do not vary according to gender.

As seen in **Table 6**, the post-test attitude scores of prospective teachers towards the history and philosophy of science course do not show a significant difference according to gender($t_{(46)} = -0.3610$, $p > 0.05$). In other words, prospective teachers' post-test attitude scores towards the history and philosophy of science course do not vary according to gender.

Findings From Prospective Teachers' Views on the History and Philosophy of Science

In this section, the findings obtained from the interviews conducted with six prospective teachers are included. The 51 codes created from the prospective teachers' answers to the interview questions and the 7 categories associated with these codes are presented in **Table 7**.

Table 7 shows that in the answers given to the question "What is science?", it is seen that it is a whole that enables the progress of society, a process that builds the future, leading to knowledge, and a resource that emerges from need and curiosity.

> PCG36: "Science is the key to the future for me. The rapid and good development of science is the shortest way to not only carry humanity to different dimensions, but also to leave a more important and useful knowledge to future generations."

> T54: "In my opinion, science is a whole that enables the progress of a society and facilitates the lives of people based on need. For me, science is a building block that makes people's work easier or creates their future, whether it is in any field, whether it is mathematics or language."

> PS44: "In my opinion, I can say that science is a way of knowledge produced based on laws, based on reality, by taking some of the facts and events in the universe and using some methods and experimental methods. In other words, there is no certainty, and it changes over time."

Pre-service teachers stated that scientific knowledge can be changed, refuted and reconstructed and therefore has the potential for constant research and self-improvement. Excerpts from some interview excerpts are presented below.

> T54: "Yes, it can change, this is something that has been going on since the past. This has also happened in the field of astronomy. I'm guessing that an idea has been revealed, Ptolemy's solar system idea has been revealed, but is that idea still continuing today? No. Scientific ideas can change in all kinds of ways."

> PS44: "Of course it may change. Because after all, he is a person who put forward this and this scientific information. Since it is not dogmatic, it may change depending on science, experiments, technological developments, that is, research. It is accepted that this information may change with experiments. Something is put forward and if the opposite is proven, the previously put forward scientific knowledge is refuted, and then it can change."

In the explanations of prospective teachers regarding the sources of information in science, the answers were generally scientists and life itself, papyrus and clay tablets.

> SS50: "Actually anything can happen, science means life. It could be books, encyclopedias, we are living in the internet age now, or a person interested in science could be a resource for us. These come to my mind right now."

> T54: "Inscriptions written in the past, ancient stones written on civilizations, and knowledge found by scientists still continuing today can be sources."

It has been stated that by enriching teaching with science history activities, lessons have become more permanent and enjoyable, and the sense of discovery has been developed.

> M21: "When I started teaching, I did not realize at first that I could learn things that I could use in classes, but then I learned and discovered new information by preparing lesson plans and learning the history of science, and it was positively beneficial in this direction."

> PCG36: "It was useful for me because it was interesting and enjoyable. My department has nothing to do with science, but it was important to me. But I think that science is a very important concept in our lives and knowing its history and how it progresses helps me progress and helps me become a more knowledgeable and cultured person."

> PS44: "I think it is useful because I think I learned the benefits of many people who have benefited us in our own country in the past. We may have known its name superficially, but we actually thought that we had come to this position as a result of our readiness, but after seeing that there were these scientists behind it, I think I understood this course better."

When we look at the answers to the question "What is the history of science?", we reach the conclusion that the history of science is a culture, a purpose for understanding humanity and human development, and a journey for this purpose.

> PCG36: "It is the very beginning of everything in our lives right now, whether it is the phone or the television. I think these are areas that deal with the how and who questions of people over time, and it is also a very important concept of culture."

> S5: "I can explain it as finding the information and the history in the process leading to the information."

> PS44: "In terms of the history of science, we can say that it has followed the path of replacing facts that were thought to be wrong in the past with scientific facts. For example, the experiments that scientists have done in the past, who did them in which century, that is, the history of this."

When asked whether the history of science course met their expectations, it was seen that they emphasized that it reinforced the desire to learn about science, increased awareness, and that the course hours should be short and should be included in the curriculum earlier.

> M21: "Yes, it was welcomed. Because I learned a lot of new information, I had also taken a history of mathematics course before, and there were similar things. I learned a lot of information that I can use in the future, and it was beneficial in this respect."

> SS50: "Actually, videos are very useful. At least it's memorable. In fact, I got curious and started watching more video content. I think I will use it a lot when I become a teacher."

Finally, when the affective aspect of the history of science was touched upon, it was seen that the focus was on the development of the academic sense of self, the sense of ownership of one's own culture and science, and that it would contribute to professional development.

> SS50: "Actually, let me say this. At first, we saw it as very simple, as if science was that simple. When I looked later, I saw that they were actually having a hard time, that they were making a lot of effort to produce or find something. So it was very positive for me."

Table 8. Ways of prospective teachers integrating history of science into lessons

5E stages	Codes	f	Total
Engage	Providing direct historical information	3	21
	Using videos about the history of science	2	
	Using photographs of scientists	2	
	Relating the history of science to daily life	2	
	Giving information about scientists	3	
	Using anecdotes and stories in the history of science	1	
	Using the brainstorming technique	1	
	Activating prior knowledge through concepts	7	
Explore	Using videos about the history of science	28	69
	Giving information about the historical development of the subject	4	
	Benefiting from life stories of scientists	1	
	Empathize with the scientists of the period	7	
	Experimentation	1	
	Drama and role playing	5	
	Finding a solution based on a problem in the history of science	7	
	Conducting research on a topic in the history of science	3	
	Using anecdote or story in the history of science	1	
	Using the brainstorming technique	8	
	Expressing opinions about the history of science	1	
	Using matching	2	
	Observation	1	
Explain	Using videos about the history of science	2	34
	Providing direct historical information	11	
	Benefiting from scientists' life stories	7	
	Giving information about the historical development of the subject	12	
	Using photographs of scientists	2	
Elaborate	Drama and role playing	7	52
	Information about scientists	2	
	Finding a solution based on a problem in the history of science	4	
	Making use of the cartoon	4	
	Using the brainstorming technique	2	
	Using the six thinking hats technique	2	
	Observation	3	
	Using the talking circle technique	2	
	Relating the history of science to daily life	1	
	Using anecdote or story in the history of science	3	
	Empathize with the scientists of the period	5	
	Using videos about the history of science	4	
	Benefiting from life stories of scientists	2	
	Using photographs of scientists	4	
	Enjoy gaming events	4	
	Conducting research on a topic in the history of science	1	
	Discussion	2	
Evaluate	Benefiting from global thinking techniques	1	5
	Enjoy gaming events	1	
	Expressing opinions about the history of science	3	

> PS44: "Actually, there have been some changes. When it comes to the history and philosophy of science, I always had a superficial knowledge, but not in depth. I thought I would only learn about the lives of philosophers, but it wasn't like that. I came across many different things, for example, Ibn-i Sina and Farabi. My thoughts about their contributions to us ranged from a narrow angle to a broad angle. So, my mistakes turned into rights after this lesson."

In addition, it was observed that the disadvantages were that the course hours were not enough, that the field was not thought to be related to the history of science, and that it would be forgotten after a while because it was verbal.

> PS44: "As a disadvantage, it is too far from my department, but as an advantage, it can also be a guide. It might be advantageous for us to follow in their footsteps."

> PCG36: "As a disadvantage, only the course hours can be extended, and more subjects can be added."

They expressed their opinions, as follows.

Findings From Prospective Teachers' Practices on the History and Philosophy of Science

Codes were created for the findings obtained from the lesson plans of the 54 prospective teachers who participated in the research, and the 5E model steps containing these codes are presented in **Table 8**.

Table 9. Ways of prospective science teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
F.3.1.1.1. Past opinions about the shape of the earth are stated	Opinions of past scientists about the shape of the earth. Magellan's studies on the shape of the world	Brainstorming, historical development of the subject, game activities, photos of scientists, & using cartoons	F1
F.3.1.2.2. It explains that there is a layer of air surrounding us on earth	Aristotle, Pythagoras, Anaximander, Battani's studies on the atmosphere and their views on the earth	Drama and role playing & global thinking techniques	F2
F.4.1.2.1. Explains the differences between the earth's rotation and rotation movements	Studies in the history of science about the shape of the earth	Direct historical information, photographs of scientists, use of video, historical development of the subject, &using matching	F3
F.4.1.2.2. Explains the events that occur as a result of the movements of the earth	Opinions of scientists who lived in the past about the movement of the earth	Direct historical information, research on the subject, drama and role playing, & game activities	F4
F.4.5.1.1. Compares the lighting tools used in the past and today	The invention of the light bulb and research on it	Historical development of the subject, solution based on a problem, six thinking hats technique, & use of video	F5
F.4.5.4.1. Compares audio technologies used in the past and today	The lives of Edward W. Kellogg, the inventor of the loudspeaker, and Alexander Graham Bell	Solution based on a problem, use of video, six thinking hats technique, & talking circle technique	F6
F.4.7.1.1 Recognizes the circuit elements that make up the simple electrical circuit and their functions	Battery, bulb, cable and switch are introduced as circuit elements. inventors of electricity	Use of video, putting yourself in the shoes of a scientist of the time, solution based on a problem, & brainstorming	F7
F.5.1.3.2. Explains the relationship between the phases of the moon and the movement of the moon around the earth	Ali Kuşçu's life and works	Use of video & empathizing with the scientists of the period	F8
F.7.2.1.2. Discusses views on the structure of the cell from past to present, relating them to technological developments	Studies on the cell by scientists such as Zacharias Janssen, Robert Hooke, Rudolf Virchow	Brainstorming, historical development of the topic, & game activities	F9
F.7.3.1.1. He calls the gravitational force acting on the mass as weight	Newton's life and scientific works	Use of video & direct historical information	F10
F.7.4.1.2. Questions how ideas about the concept of atom have changed from past to present	Atomic models from past to present	Photographs of scientists, expressing opinions about the history of science, historical development of the subject, & drama and role playing	F11
F.7.5.3.1. He discovered that light changes direction when passing from one transparent medium to another	Ibn Haytham's studies on light	Using video & empathizing with the scientist.	F12
F.7.7.1.3 Define electric current	The story of electricity from past to present (Franklin, Coulomb, Edison, Georg Ohm)	Relating to daily life, talking circle technique, putting yourself in the shoes of a scientist, using cartoons, & giving direct historical information	F13
F.8.1.1.1. Makes predictions about the formation of seasons. It tells the results about the positions of the world	The sun hits the tomb of Ramses II in Egypt only twice a year.	Direct historical information & observation	F14
F.8.2.2.1. Defines concepts related to inheritance	Mendel's science and life story	Benefiting from the scientist's life story & direct historical information	F15
F.8.6.4.4. It offers solution suggestions using research data on the contribution of recycling to the country's economy	Sustainable development studies of past civilizations	Historical development of the subject	F16

From **Table 8**, the frequency of use of the steps of the 5E learning model by pre-service teachers in integrating the history of science into the lessons is deepening, discovery, explanation, introduction and evaluation, respectively. In the introduction stage, they use the history of science as "activating concepts", "giving information about scientists" and "giving direct historical information", and in the discovery stage, they use "video on the history of science", "brainstorming technique", "looking at a problem in the history of science". It was determined that they used it in the form of "finding solutions".

In the explanation step, usages such as "life stories of scientists", "giving direct historical information about the subject" and "using photographs of scientists" were identified, in which theoretical parts about the subject were given. In the deepening step, the use of "drama and role playing related to the subject", "empathizing with the scientists of the period", "using cartoons" and using thinking techniques were seen. In the evaluation phase, "expressing opinions about the history of science" and "using global thinking techniques" were used as a summary of the subject. **Table 9** presents the ways prospective science teachers include the history of science in their lesson plans.

As seen in **Table 9**, it was observed that prospective science teachers benefited from common achievements while preparing the lesson plan, and in line with these achievements, they touched upon the history of science that developed and changed with the discoveries of the scientists living in that period. History of science in science in general; Views about the world and the universe, concepts related to electricity, sound technology, the discovery of the cell, light and heredity have been influential. **Table 10** presents the ways that prospective mathematics teachers include the history of science in their lessons.

Table 10. Ways of prospective mathematics teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
M.2.3.3.2. Explains the relationship between time measurement units	Time measurement and studies in ancient times	Activating prior knowledge on concepts, finding a solution based on a problem, & direct historical information	M1
M.6.1.2.3. Determines prime numbers by their properties	Eratosthenes' sieve of prime numbers	Use of video, finding a solution based on a problem, benefiting from the scientist's life story, giving information about scientists, & brainstorming	M2
M.6.3.5.1. Recognizes liquid measurement units and converts them to each other	Liquid measuring tools used from past to present	Use of video&/ direct historical information	M3
M.7.1.3.5. Solves problems that require operations with rational numbers	Mathematical operations performed by Thomas Edison while inventing the light bulb	Relating the history of science to daily life & doing research on a topic	M4
M.8.3.1.5. Creates the Pythagorean theorem and solves related problems	Pythagoras' life and contributions to mathematics	Activating prior knowledge through concepts, direct historical knowledge, brainstorming, using video, drama and role playing, Using cartoons, & empathizing	M5
M.8.3.4.1. Recognizes right prisms, determines their basic elements, constructs them and draws their expansion	Past studies on prisms (Euclidean and Euler)	Video usage, providing information about scientists, & direct information giving	M6
M.8.5.1.5. Calculates the probability of a simple event occurring	The emergence of the concept of probability with Pascal	Finding a solution based on a problem, empathy, & direct historical knowledge	M7

Table 11. Ways of PCG prospective teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
10.3.3. Explains the subject and problems of philosophy of science	The value of science and important scientists	Information about scientists, use of video, brainstorming, giving direct historical information, expressing opinions about the history of science, & debating	PCG1
10.4.1. Analyzes a philosophical text	John Dewey's reflections on pragmatism and slope	Using videos about the history of science, brainstorming, providing direct historical information, discussion, & question-answer-comparison technique	PCG2
11.1.1. Explains the thought environment that prepared the emergence of philosophy	Historical development of anthropology (Herodotus, Marco Polo) & discussing the thoughts of Thales, Anaximander, Anaksimenes, Socrates, and Democritus	Using videos about the history of science, researching a topic, question and answer technique, brainstorming, & using stories and anecdotes	PCG3
11.1.3. Analyzes the views of philosophers of the 6th century BC-2nd century AD, based on sample texts	Scientists dealing with alchemy and their inventions	Activating prior knowledge through concepts, conducting experiments, making observations, informing scientists, photos of scientists, & game activities	PCG4

Table 12. Ways of social studies prospective teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
SB.6.4.3. Conducts research using scientific research steps	How to prepare a scientific study. How did scientists who lived in the past conduct research? (philosophers in ancient times)	Finding a solution based on the problem, using the talking circle technique, information about scientists, drama and role playing, brainstorming technique, & Providing direct historical information	S1
SB.7.4.2. Discusses the contributions of scholars raised in the Turkish-Islamic civilization to the scientific development process	The lives and works of scientists such as Ömer Hayyam, El Harezmi, Piri Reis, Ali Kuşçu, Ibn-i Sina, Farabi, & Katip Çelebi	Using photographs of scientists, video about the history of science, role playing-empathy, direct historical information empathy, & benefiting from global thinking techniques	S2

In **Table 10**, it is seen that in the lesson plans prepared by prospective mathematics teachers, they focused on the reflections of the inventions and tools that emerged in the past when people needed science in the direction of mathematical science. It seems that the focus is on concepts such as time, numbers and shapes, and probability.

When we look at the prospective psychological counseling and guidance teachers in **Table 11**, it is seen that they prepared plans directly on the history and philosophy of science. Examples of philosophical thought movements that emerged with science and the scientists who revealed these ideas are given. It has been seen that they deal with the understanding of science, the value of science and important people who put forward scientific views.

According to **Table 12**, when it comes to prospective social studies teachers, although the content of the lesson plans of all six participants is different, it is seen that the frequency decreases because common outcomes are used. In these plans, it is seen that

Table 13. Ways of pre-school prospective teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
Learning outcome 2: Makes predictions about the object/situation/event	Thales' story and his work on shadow	Empathy, direct information giving experimentation, & drama and role playing gaming events	PS1
Learning outcome 3. Expresses herself in creative ways	Ibn Sina's life and work in the field of health	Information about a scientist, using videos about the history of science, doing experiments, making observations, & game activities	PS2
Learning outcome 5: Observes objects or entities	History of beans	Providing information about the historical development of the subject, using photographs of scientists, observation-experiment, & using stories and anecdotes	PS3
Kazanım 19: Provides solutions to problem situations	Ali Kuşçu and her studies on space	Finding solutions based on the problem, using photos of scientists, drama and role playing, & using videos	OÖ4

Table 14. Ways of Turkish prospective teachers to include the history of science in their lesson plans

Learning outcome	Content	Application	PT
T.4.4.4. Writes informative text	Life and work of philosophers	Giving information about scientists, using photographs of scientists, & empathy	T1

Table 15. Ways to integrate the history of science into the lesson in 5E lesson plans

Methods	Science	Maths	Pcg	Social	Preschool	Turkish	Total
Providing direct historical information	5	4	2	1	1	1	**14**
Using videos about the history of science	7	4	3	1	2	-	**17**
Using photographs of scientists	3	-	1	1	2	1	**8**
Don't brainstorm	3	2	3	1	-	-	**9**
Using anecdotes and stories	-	-	1	-	1	-	**2**
Activating prior knowledge through concepts	-	2	1	-	-	-	**3**
Drama and role playing	2	1	-	2	2	-	**7**
Experiment and observe	1	-	1	-	3	-	**5**
Don't empathize	5	2	-	1	1	1	**10**
Giving information about the historical development of the subject	5	-	2	1	1	-	**9**
Finding a solution based on a problem	3	3	1	1	1	-	**9**
Using global thinking techniques	5	-	1	1	-	-	**7**
Making use of the cartoon	1	1	-	-	-	-	**2**
Enjoy gaming events	2	-	1	-	2	-	**5**
Total	**42**	**19**	**17**	**10**	**16**	**3**	

attention is drawn to the contribution of scientists who are active in the Turkish-Islamic civilization to the history of science and the use of scientific research steps.

Table 13 shows that prospective pre-school teachers integrated ways in which children could express themselves in creative ways, such as experimentation, drama and role playing, putting themselves in the shoes of the scientist at that time, and benefiting from scientific research steps, into their lesson plans.

According to **Table 14**, since there is only one prospective Turkish teachers, it is seen that he uses the history of science on the informative text based on the lives and works of philosophers.

Considering all these, it was seen that the prospective teachers integrated the history and philosophy of science into the achievements in different subject areas. Although prospective teachers differed from department to department, it was observed that they included prominent scientists such as Ali Kuşçu, Edison, Thales, Pythagoras, Newton, Galileo and Ibn-i Sina in their lesson plans.

Table 15 shows that prospective science teachers and then prospective mathematics teachers included the history of science in their lesson plans. This may be due to the fact that famous scientists have done studies in the field of science and mathematics, and that scientists are given more space in science and mathematics education courses.

DISCUSSION AND CONCLUSION

It was observed that there was a statistically significant difference in favor of the post-test between the averages of pre-test and post-test attitude scores of prospective teachers towards the history and philosophy of science course. In this case, it can be said that it has a positive effect on the attitudes of prospective teachers towards the history and philosophy of science course. In his study, Baran (2013) supported the existing teaching with the history and philosophy of science method and concluded that it positively affected students' motivation and scientific attitudes towards science lessons compared to traditional teaching. Similarly, Bakanay and Güney (2018) concluded that prospective teachers often perceive the use of history of science for

conceptual purposes and that they consider the history of science teaching as an enriching and supportive resource. In his study, Yıldırım (2021) concluded that there was a significant difference in the attitudes of prospective science teachers towards the nature of science after teaching the history of science supported by activities. While it was inferred that prospective teachers did not have sufficient knowledge about the subject area of history and philosophy of science at the beginning of the process, it was seen that the average was positive at the end of the process. Justi and Gilbert (2000) state that, in addition to contemporary teaching methods, methods that do not include the history of science will leave students neutral towards science and the history of science and will not be able to develop positive attitudes. It can be said that the reason for the positive result in this study is that the history of science has no boundaries like an endless universe and that it will provide prospective teachers with a fresh perspective throughout their lives.

Çelik (2019) used history of science applications in science classes and examined their effects on secondary school students' attitudes and epistemological beliefs towards science. As a result of his research, it was determined that the use of history of science applications in science lessons and the attitudes and epistemological beliefs of secondary school students differ significantly according to gender. It is thought that the reasons for the effects of this situation are related to teacher behaviors, social norms and the curriculum (Özyurt, 2004). Pre-test attitude scores of prospective teachers towards the history and philosophy of science course do not vary according to gender. When the post-test results of the prospective teachers were examined according to the gender variable, it was seen that it was for the female prospective teachers and for the male prospective teachers.

In line with the answers received from a total of thirteen questions asked to the prospective teachers, the prospective teachers discussed the definition of science, the sources of information in the history of science, whether scientific knowledge will change or not, what the concept of the history of science means, their perspectives on the history of science course they took throughout the semester, and their experiences in preparing the history of science lesson plan. difficulty and their opinions about the use of video in the history of science course constitute the general scope of the questions. When the answers given are examined and analyzed, the similarities and differences in the answers of the prospective teachers are noticed. This may be an indication that the history and philosophy of science course is not monotonous and is not viewed from a fixed perspective. Based on the answers given by the prospective teachers in this research, it is understood that they have not been active in any activity or course process related to the history of science before. At the end of the research process, it can be interpreted that the prospective teachers' opinions about the history of science were positive and the answers to their opinions were consistent. The changes of prospective teachers before and after the history of science course are parallel to the results of many studies in the literature. For example, Yıldırım (2021) concluded in his study that teaching the history of science with activities provided a positive development in prospective teachers' views on the nature of science. In the study conducted by Yıldırım (2021), it was determined that prospective science teachers found teaching the history of science with activities useful and instructive, according to course evaluation forms and opinion interviews. When various studies and literature are examined, the history and philosophy of science course, activities based on the history of science, books, and stories used have provided positive developments in the opinions of both prospective teachers and students (Beşli, 2008; Güney, 2014; Kaya, 2007; Şimşek & Şimşek, 2010; Tekfidan, 2018).

The lesson plans prepared by prospective teachers in their practices for the history and philosophy of science course were analyzed and interpreted in depth. When we look at the general view of the prospective teachers, it is seen that they activate the history of science in the discovery stage of the 5E model and attract the attention of the students here. Since it is the student who needs to be active in the discovery phase, it has been observed that research, questioning, wondering, finding solutions to problem situations and brainstorming techniques are used in this part, and it can be inferred that the use of situations that activate the process has caused intensity in this part. Another point; the category of "using video in the history of science", which is most frequently used in the discovery step, is parallel to the positive results obtained from the use of video in the history of science in the third sub-problem, the opinions of pre-service teachers. When the opinions of prospective teachers are examined, it can be said that understanding the 5E learning model and reinforcing it with the essence of the subject during the lesson plan preparation process makes the lessons more active and makes learning permanent. From the opinions obtained, it can be concluded that 5E lesson plans support permanent learning and that prospective teachers have the knowledge and desire to integrate the history of science into lessons.

It can be interpreted that the fact that prospective teachers generally used certain techniques in the process of preparing lesson plans should come to light more in the part of understanding and emphasizing the history of science. In the study of Mıhladız and Doğan (2017), prospective teachers have similar opinions about teaching methods and techniques such as lecture, question and answer, brainstorming and 5E model in science lessons. They reached the opinion that science history stories, scientists' lives, science history anecdotes and videos are effective in understanding the nature of science by using drama and role playing techniques. Prospective teachers need more proficiency within this course. It can be said that increasing the importance given will also be effective in bringing a new breath to the studies on the subject. However, the impact of the history and philosophy of science on education can be examined on different topics and similar studies in the literature can be increased.

Author contributions: EŞ: conceptualization, formal analysis, investigation, writing - original draft; **ETK:** methodology, conceptualization, writing - review and editing; **TK:** methodology, formal analysis, investigation, writing - review and editing. All authors agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: The authors stated that the study was approved by the Zonguldak Bülent Ecevit University Human Research Ethics Committee on 31 December 2020 with approval code 1014. Written informed consents were obtained from the participants.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Adúriz-Bravo, A., & Izquierdo-Aymerich, M. (2004). The discovery of radium as a 'historical setting' to teach some ideas on the nature of science. In D. Metz (Ed.), *Proceedings of the 7th International History, Philosophy, and Science Teaching Conference* (pp. 12-19). University of Winnipeg.

Alışır, Z. N., Deniz, L., & İrez, O. S. (2020). Bilim tarihi tutum ölçeği: Geliştirilmesi, geçerlik ve güvenirlik çalışması [History of science attitude scale: Development, validity and reliability study]. *Trakya Eğitim Dergisi, 10*(3), 835-853. https://doi.org/10.24315/tred.649863

Allchin, D. (2013). *Teaching the nature of science: Perspectives resources*. SHiPS Education Press.

Bakanay, C. D. & Guney, B. G. (2018). Pre-Service biology teacher"s perceptions about using history of science in science instruction. *Science, Education, Art and Technology Journal, 2*(2), 109-115.

Baran, B. (2013). *The effect of the history and philosophy of science teaching method on attitudes and motivation regarding science* [Unpublished master's thesis, Gaziosmanpaşa University, Institute of Educational Sciences, Tokat].

Beşli, B. (2008). *The effect of prospective science teachers' analysis of sections from the history of science on their views on the nature of science* [Unpublished master's thesis, Abant İzzet Baysal University, Institute of Social Sciences. Bolu].

Bilgin, N. (2006). *Sosyal bilimlerde içerik analizi: Teknikler ve örnekler çalışmalar* [Content analysis in social sciences: Techniques and case studies]. Siyasal Kitabevi.

Çelik, A. B. (2019). *Bilim tarihi uygulamalarının ortaokul öğrencilerinin bilim ve fene yönelik tutum ve epistemolojik inançlarına etkisinin incelenmesi* [Investigating the effects of history of science applications on middle school students' attitudes and epistemological beliefs towards science] [Unpublished master's thesis, Yıldız Teknik Üniversitesi, İstanbul].

Çepni, S. (2001). *Araştırma ve proje çalışmalarına giriş* [Introduction to research and project work]. Erol Ofset Matbaacılık ve Ambalaj Sanayi.

Çepni, S., Ayas, A., Johnson, D., & Turgut, M. F. (1997). *Fizik öğretimi* [Teaching physics]. YÖK/Dünya Bankası Milli Eğitimi Geliştirme Projesi Hizmet Öncesi Öğretmen Eğitimi.

Çolakoğlu, J. (2002). Yaşam boyu öğrenmede motivasyonun önemi [The importance of motivation in lifelong learning]. *Milli Eğitim Dergisi*, 155-156.

Güney, B. G. (2014). *Evaluation of the suitability of history of science based teaching materials to physics course curriculum and instruction* [Unpublished doctoral thesis, Marmara University, İstanbul].

Hacieminoglu, E., Ertepınar, H., & Yılmaz Tüzün, O. (2012). Pre-service science teachers' perceptions and practices related to history of science instructions. *International Journal on New Trends in Education and Their Implications, 3*(3), 53-59.

Hurd, P. (1998). Scientific literacy: New minds for a changing world. *Science Education, 82*(3), 407-416. https://doi.org/10.1002/(SICI)1098-237X(199806)82:3<407::AID-SCE6>3.3.CO;2-Q

İrez, S., Bakanay, Ç. D., Şeker, H., Güney, B. G., Kahveci, A., & Barutcuoğlu, S. S. (2011). A typology of science teachers' aims in incorporating the history of science in science teaching. In *Proceedings of the International History, Philosophy and Science Teaching Conference* (pp. 359-365).

Kaya, A. (2007). *Evaluation of the effects of history of science supported teaching on the views of science teacher candidates on the nature of science* [Unpublished master's thesis, Balikesir University, Institute of Science, Balikesir].

McMillan, J. H. (2000). *Educational research: Fundamentals for the consumer*. Addison Wesley Longman Inc.

MEB. (2013). *Ortaöğretim biyoloji dersi 9, 10, 11 ve 12. sınıflar öğretim program* [Secondary school biology course 9, 10, 11 and 12th grade curriculum]. MEB Talim Terbiye Kurulu Başkanlığı Biyoloji Öğretim Programı Komisyonu.

Mıhladız, G., & Doğan, A. (2017). Investigation of the pre-service science teachers' pedagogical content knowledge about the nature of science. *Hacettepe University Journal of Education, 32*(2), 380-395. https://doi.org/10.16986/HUJE.201601722

Narguizian, P. J. (2002). *The history of science in secondary biology textbooks in the United States: A content analysis* [Unpublished toctoral thesis, University of Southern California, CA, USA].

Özdemir, G., & Akçay, H. (2009). Bilimin doğası ve bilim tarihi dersinin öğrencilerin bilimin ve bilimsel bilginin doğasına ilişkin düşüncelerine etkisi [The effects of the nature of science and history of science course on students' thoughts on the nature of science and scientific knowledge]. *Education Sciences, 4*(1), 218-227.

Şimşek, C. L. (2011). Bilimin doğası ve bilim tarihi dersinde yapılan çalışmaların öğrencilerinin bilim tarihi ile ilgili bilgi düzeylerine etkisi [The effects of studies conducted in the nature of science and history of science course on students' knowledge levels about the history of science]. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 5*(1), 116-138.

Şimşek, C. L., & Şimşek, A. (2010). Türkiye'de bilim tarihi öğretimi ve sosyal bilgiler öğretmen adaylarının yeterlilikleri [Teaching history of science and social studies teacher candidates' competencies in Turkey]. *Uluslararası İnsan Bilimleri Dergisi, 7*(2), 169-198.

Şipşak, E. (2023). *Investigation of prospective teachers' views, attitudes and practices towards history and philosophy of science* [Unpublished master's thesis, Bülent Ecevit University, Zonguldak].

Tekfidan K. (2018). *A phenomenology study: Teaching history of science enriched with activities in physics education* [Unpublished master's thesis, Gazi University, Institute of Educational Sciences, Ankara].

Topdemir, H. G., & Unat, Y. (2018). *Bilim tarihi* [History of science]. Pegem Akademi.

Wang, H. A., & Cox-Petersen, A. M. (2002). A comparison of elementary, secondary and student teachers' perceptions and practices related to history of science instruction. *Science & Education, 11*(1), 69-81. https://doi.org/10.1023/A:1013057006644

Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in social sciences]. Seçkin Yayıncılık.

Yıldırım, C. (2021). *Bilim tarihi* [History of science]. Remzi Kitabevi.

Yin, R. (1984). *Case study research: Design and methods*. SAGE.