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A Study on Scientific Thinking Skills and Professional Experience of Teachers

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Abstract

Scientific thinking is considered as a cognitive process in which the underlying causes of a basic problem are solved. It is of great importance for teachers to have scientific thinking skills to improve their professional lives, to create effective learning environments, to continuously question the events and processes in the classroom, to carry out research, to identify problems and to produce solutions. The aim of this study is to determine whether there is a significant difference between teachers' scientific thinking skills and variables such as gender, seniority and branch. The research was conducted based on the comparative descriptive survey model. The data obtained concerning the demographic characteristics of the teachers were analyzed with frequency and percentage techniques. In the analyses between the demographic characteristics of the subjects and their scientific thinking skills, arithmetic mean, t-test and one-way analysis of variance (ANOVA), which were selected according to the characteristics of the groups, were used. For the research, the Scientific Thinking Skills Scale developed by Göktürker (2005) was adapted into Kazakh and applied to the teachers. According to the findings of the study, the scientific thinking skills of the participant teachers were found to be at a medium level. In addition, significant differences were found in teachers' scientific thinking skills according to gender, branch and professional seniority factors.

Introduction

Changes in the theoretical general framework of educational goals and the findings of cognitive psychology have been reflected in every stage of education and training, and thus have affected the structure and achievements of curricula, which are an important element of education. In particular, it has become a necessity to utilize scientific thinking, critical thinking, creative thinking, reflective thinking, analytical thinking, metacognitive thinking and lateral thinking skills, which are among the higher order thinking skills, in the problem solving process of students. This radical change in the understanding of science has naturally had repercussions on education. In recent years, reforms in the field of education in many countries have emphasized the significance of students having a modern

understanding of science (Akdeniz et al., 2016; Lederman & Lederman, 2004) and the main purpose of education has been stated as educating students as "science literate" and scientific thinkers (AAAS, 1989; National Research Council, 2000). The National Science Teachers Association (NSTA, 1982) and the National Research Council (NRC, 1996) emphasized the importance of students' understanding of the nature of science as a basis for scientific thinking.

Teachers' views of science are often quite different from the current view of science as a result of years of behaviorist education. For years, science programs have emphasized the transmission of scientific facts to students rather than the development of understanding. Such a field education has generally encouraged students to memorize scientific concepts and principles rather than developing thinking skills and understanding of the nature of science (Al-Husban, 2020; Oh & Oh, 2011; Polat, 2020; Smith & Scharmann, 1999; Tosun, 2000; Yurt, 2022).

One of the 21st century skills is the concept of thinking skills. Thinking skills are dominant in every field in our digital age. It finds its place in education, technology, art and many other fields. Thinking skills, which also give a significant direction in education programs, also facilitate the person to keep himself up to date in a changing and developing world. In education, it has become a requirement especially in some branches. In particular, since teachers do a lot of thinking, having high-level thinking skills has become a priority (Anagün, 2018; Hajer. & Hatem, 2022; Hajer, Thouraya, & Nejiba, 2022; Kivunja, 2014; Sari & Sünbül, 2004; Urbani et al., 2017).

Thinking has been handled in different ways by different learning theorists. Behaviorists have stated that thinking occurs as a result of the learning event, while cognition theorists have stated that it is an internal process similar to learning (Mumford et al., 2013; Scheinkopf, 1999; Shore & Kanevsky, 1993). Thinking can be defined as cognitive behavior in which ideas, images, mental representations or other hypothetical elements of thought are experienced or manipulated. In this sense, thinking includes imagining, remembering, problem solving, fantasizing, free association, concept formation and many other processes. Thinking can be said to have two defining characteristics: (a) it is implicit-that is, it is not directly observable but must be inferred from actions or self-reports; and (b) it is symbolic-that is, it appears to involve operations on mental symbols or representations, the nature of which is uncertain and contested (APA, 2022). Thinking (also called thinking) - is the mental process by which entities form psychological relationships and models of the world. Thinking allows people to make sense of, interpret, represent or model the world they experience and make predictions about that world. It therefore helps an organism with needs, goals and desires when making plans or making other attempts to achieve them. Perhaps this is how science came into existence and can be passed on to future generations (Raghavan, 2014).

Thinking is a continuous and never-ending activity and has various stages. It covers all stages of an individual's life. This fact reveals that the education the individual will receive should prepare him/her for life. Individuals need thinking skills both for the four operations skills used in shopping in their daily lives and for taking initiatives that will make their lives easier. This is why thinking is at the forefront in education systems based on progressivism. Thus, instead of memorizing information in education and training, individuals prepare themselves for life by developing their thinking skills (Ergüven, 2011; Rodgers, 2002; Tan, 2016). In Dewey (1910), thinking is defined as "believing (or not believing) without being direct; it means believing (or not believing) through

observation, evidence and support with documents; this is the basis of the idea." Thinking as defined by Dewey (1933) is an educational research method based on problem solving. The basic idea covers the problems that the individual faces and solves in line with the scientific method (Baron, 1981; Papadimos, 2009).

It is evident that thought processes are a cognitive process that appears in the form of a creative reflection by the subject of reality and produces a result that is not currently directly present in reality or in the subject. Thinking can be physiologically, psychologically and cognitively influenced. The inputs to the thinking process are data, information, evidence, beliefs and sensations. The term "thinking skills" refers to the specific mental and cognitive processes a person uses to think effectively. Basically, thinking skills are what we use in our heads to solve problems, reason, infer, and hypothesize (Borge, Ong & Rosé, 2018; Foster, 2004; Kim, Mabin & Davies, 2008).

Thinking skills are also classified as higher-order and basic-level skills. There are different classifications of higher-order thinking skills in the literature (Abosalem,, 2016; Collins, 2014; Lewis & Smith, 1993). As a result, it is seen that the classifications related to thinking vary (APA, 2022; Raghavan, 2014). Zohar and Dori (2003) emphasized that developing higher-order thinking skills is one of the important goals of educational institutions due to its effects on learning and teaching performance. The findings from Zohar and Dori's (2003) study revealed that students with high learning outcomes had higher thinking skills scores compared to their peers with lower learning performance. Miri et al. (2007) suggest that teachers need to develop competencies and professional programs to support and encourage students to perform tasks that require higher order thinking skills (Hugerat & Kortam, 2014; Kwangmuang et al., 2021; Sulaiman et al., 2017; Zohar & Dori, 2003).

Scientific thinking skills literature has classified the characteristics of the scientific thinking process and explained them in seven sub-dimensions (rationality, skepticism, suspension of belief, distrust of argument from authority, open-mindedness, curiosity and objectivity) (Bağ & Çalık, 2021; Çalık & Coll; Elby & Hammer, 2001; Gauld, 1982; Hodson, 2003; ,Kolstø, 2001; Ringland, 2008). These dimensions and key features of the dimensions have been summarized in detail by the researchers. There are limited studies on scientific thinking skills in the literature. Coll and Taylor (2004), in a study conducted with scientists from different branches, found that scientists were open-minded about beliefs about the existence of aliens and ghosts, saw potential theoretical explanations as a need, and generally neglected experimental evidence without basic explanations. As it is understood from these studies, studies on scientific thinking skills have been investigated with higher age groups and using socioscientific topics. Thus, it is aimed to develop scientific thinking skills through socioscientific issues that concern society and science, including controversial, complex and dilemmas with no definite answer (Asmoro & Prayitno, 2021; Kolstø et al., 2006; Wiyarsi & Çalık, 2019; Zeidler, 2001).

It is crucial for teachers to have scientific thinking skills to improve their professional lives, to create effective learning environments, to continuously question the events and processes in the classroom, to conduct research, to identify problems and to produce solutions. Teachers' scientific thinking plays a major role in realizing the goals of their lessons, generating solutions to the problems encountered in the learning-teaching process, and evaluating their experiences in the classroom (Aslan, 2016; Lawson, 1995; Erman, Wasis, Susantini & Azizah, 2018; Sünbül, 2011). Scientific thinking can also be considered as an important research topic in terms of in-

service and pre-service teacher education. Effective teachers are those who use scientific thinking in their teaching activities, as it is a necessary characteristic of successful and responsible teachers. Therefore, scientific thinking should be considered as an important part of teacher education and training programs (Aldahmash, Alshalhoub & Naji, 2021; Day, 2002; Murtonen & Salmento, 2019; Zenker, 2020).

Teachers try to challenge students to know and practice how to build the structure of critical abilities in areas such as studying topics that have personal meaning for them, formulating researchable problems or testing hypotheses, making logical connections between scientific concepts that guide a hypothesis and designing an experiment, planning and managing scientific investigations (Li & Klahr, 2006; Orion & Kali, 2005; Qarareh, 2016). In all these areas, teachers need to develop skills for the use of a variety of thinking skills, for example: elucidating and testing the ideas that drive scientific inquiry and using appropriate methods for collecting, analyzing and presenting data, developing formulas for making statements, tables and graphs for discussing results; what the inquiry itself entails for elucidating research questions, methods, comparisons and variables; organizing and presenting data; reviewing methods and explanations; using evidence, using logic, developing arguments for proposed explanations; preparing and revising models (physical, conceptual and mathematical) and scientific explanations using logic and evidence; arguing and defending ideas based on scientific knowledge; using logic and evidence from investigations that result in revising explanations; conducting an opinion analysis by critiquing prevailing scientific understanding, weighing and weighing evidence using scientific criteria to find preferred explanations and models, examining the logic that decides which explanations and models are best. This new emphasis on scientific inquiry represents a fundamental shift from teaching science as "discovery and experimentation" to teaching science as "discussion and explanation" (Duschl & Osborne, 2002; Hoadley & Linn, 2000; Narode, 1987; National Research Council, 2000; Schultz, 2003).

Wing (2011) defined scientific thinking skills as thought processes that involve the formulation of problems and their solutions so that solutions can be effectively implemented by an information processing agent. Roman-Gonzalez (2014) considered it as a cognitive process in which the underlying causes of a basic problem are solved. BCS (2014) defined computational thinking as a set of mental skills that transform complex, messy, partially defined, real-world problems into a form that a mindless computer can overcome without the help of another human (CTSA & ISTE, 2011; Yasar et al., 2022). CTSA & ISTE (2011) defined scientific thinking as a problem solving process that includes (but is not limited to) the following characteristics: • Organizing and analyzing data logically •Representing data through scientific models • Automating solutions through algorithmic thinking •Identifying, analyzing, and implementing possible solutions to achieve the most efficient and effective combination of steps and resources •Generalizing and transferring this problem-solving process to a variety of problems.

Characteristics such as critical and creative thinking, scientific thinking, problem solving, analysis, research, teamwork, creating effective learning environments, accessing, verifying, reflecting and transferring knowledge, using technology effectively, and having the competencies to teach academic knowledge are emphasized in the reports published by institutions that have international studies within the scope of teacher education (National Research Council, 2011; Partnership for 21st Century Learning, 2015; Thematic Network on Teacher Education

in Europe 2000; European Commission, Directorate-General for Education and Culture, 2010; Hyytinen, Toom & Shavelson, 2019). According to these reports, since future education will be project and research-oriented, teachers need to have holistic scientific thinking and research skills (ETUCEEuropean Trade Union Committee for Education, 2008; OECD, 2018).

In this study, the scientific thinking skills of teachers working in Kazakhstan were examined comparatively in terms of some variables. In relation to this purpose, answers to the following questions were sought in the study:

- What is the level of teachers' scientific thinking skills?
- Do teachers' scientific thinking skills differ according to gender variable?
- Do teachers' scientific thinking skills differ according to the branch variable?
- Do teachers' scientific thinking skills differ according to the variable of professional seniority?

Method

The study was designed according to the single survey model, one of the general survey models. General survey models are survey models that are conducted on the whole universe or a group, sample or cluster to be taken from it in order to make a general judgment about the universe in a universe consisting of a large number of elements. In this type of approach, the variables belonging to the event, item, individual, group, subject, etc. unit and situation are tried to be described separately. According to Kaptan (1998), studies that try to describe and explain "what" events, objects, assets, institutions, groups and various fields are descriptive studies. Descriptive studies aim to explain the interaction between situations by taking into account the relationships of current events with previous events and conditions. In this sense, examining the data obtained through scale evaluation in order to reveal the scientific thinking skills of teachers provided a realistic environment.

The population of the study consists of teachers working in public and private primary and secondary schools in Almaty, Kazakhstan in the academic year 2022. The number of individuals to be sampled was determined as 212 in the calculation made with the sampling calculation formula n = N t2 p q / d2 (N-1) + t2pq (Salant & Dillman, 1994) by accepting the significance level as .05. In this study, the element sampling type was taken as a basis and 214 teachers were reached by using the random method in determining the sample. 107 of the participants were female (50%) and 107 were male (50%). When the distribution of the teachers according to their professional seniority was analyzed, it was seen that 42 of them had 0-5 years, 53 of them had 6-10 years, 67 of them had 11-19 years and 52 of them had 20 years or more of professional working time.

Data Collection Tools

Personal Information Form

In this section, it was aimed to obtain the personal information of the participants. For this purpose, it includes personal information consisting of 4 variables related to gender, seniority in teaching, educational status and branches.

Scientific Thinking Skills Scale

In the study, the Scientific Thinking Skills Scale (STBS) developed by Göktürkler (2005) was used to measure teachers' scientific thinking skills. This scale developed by Göktürkler (2005) is a 5-point Likert-type scale consisting of 42 items. This scale consists of 4 sub-factors: Problem solving/scientific thinking, Critical/scientific thinking, Creative/scientific thinking and Information gathering/organizing. Teachers are asked to respond to the items in this scale on a 5-point scale: never, rarely, sometimes, often, often, always. The highest score in the scale is 5. For example, it can be said that a teacher who marks "always (5)" for the statement "I can find more than one solution to a problem" always demonstrates this behavior. In Göktürker's (2005) study, the reliability coefficient of the scale was found as Cronbach Alpha = 0.86. In this study, the reliability coefficients for the sub-dimensions of the scale ranged between .81 and .88.

Data Analysis

In the data collection process, the values of the scales answered by the participants were carefully transferred to the computer environment. Unanswered questions and questions with more than one answer were not included in the study. Before starting the analysis process, it was tested whether the scale values showed a normal distribution. Central dispersion, skewness and kurtosis values were examined on the factors in the scale, and since the Kolmogorov-Smirnov Test result on the scales was $p>0.05$, it was seen that the assumptions of normal distribution were met. In this context, F test was used to compare teachers' scientific thinking skills according to their professional seniority and experience, and t test techniques were used for comparisons according to gender and school type.

Findings

Table 1 shows the averages of teachers' responses to the 'Scientific Thinking Skills Scale and Subscales'. As seen in the table, the average of their responses is 2.76 in the critical/scientific thinking subscale, the average of their responses is 2.81 in the Creative/scientific thinking subscale, 3.29 in the Problem solving/scientific thinking subscale, 4.01 in the Information gathering/organizing subscale and 3.22 in the whole scale. According to the mean scores, the participant teachers' 'Critical/scientific thinking' and 'Creative/scientific thinking' skills are low, 'Problem solving/scientific thinking' skills are medium, and Information gathering/organizing skills are high. In general, it is seen that teachers have a medium level of scientific thinking skills.

Table 1. Descriptive Analyses of Teachers' Scientific Thinking Skills Scale Scores

Scientific Thinking Skills	N	Minimum	Maximum	Mean	Std. Deviation
Critical/scientific thinking	214	1.50	5.00	2.76	0.28
Creative/scientific thinking	214	1.00	4.60	2.81	0.95
Problem solving/scientific thinking	214	2.00	5.00	3.29	0.54
Collecting/organizing information	214	2.00	5.00	4.01	0.62
Scientific Thinking Average	214	2.25	4.21	3.22	0.32

Table 2. Comparison of Teachers' Scientific Thinking Skills Scale Scores According to Gender Variable

Scientific Thinking Skills	Gender	N	Mean	Std. Deviation	t	P
Critical/scientific thinking	Female	107	2.72	0.33	-1.99	0.04
	Male	107	2.80	0.22		
Creative/scientific thinking	Female	107	2.78	0.99	-0.40	0.69
	Male	107	2.83	0.92		
Problem solving/scientific thinking	Female	107	3.26	0.51	-0.79	0.43
	Male	107	3.32	0.57		
Collecting/organizing information	Female	107	4.04	0.64	0.58	0.56
	Male	107	3.99	0.60		
Scientific Thinking Average	Female	107	3.20	0.36	-0.68	0.50
	Male	107	3.23	0.29		

As seen in Table 2, only Critical/scientific thinking [$t(214) = 1.99$, $p<0.05$) was found to be significantly different between teachers' scientific thinking skills according to gender. On the other hand, no significant difference was found in Creative/scientific thinking, Problem solving/scientific thinking, Information gathering/organizing and the whole scale according to gender factor. In terms of critical/scientific thinking, it was observed that male teachers had higher mean scores than their female colleagues.

Table 3. Comparison of Teachers' Scientific Thinking Skills Scale Scores According to Subject Variable

Scientific Thinking Skills	Branch	N	Mean	Std. Deviation	t	P
Critical/scientific thinking	Social	104	2.77	0.23	0.157	0.875
	Sci-Math	110	2.76	0.32		
Creative/scientific thinking	Social	104	2.89	0.91	1.205	0.230
	Sci-Math	110	2.73	1.00		
Problem solving/scientific thinking	Social	104	3.30	0.55	0.248	0.804
	Sci-Math	110	3.28	0.54		
Collecting/organizing information	Social	104	3.90	0.66	-2.531	0.012
	Sci-Math	110	4.11	0.57		
Scientific Thinking Average	Social	104	3.21	0.31	-0.167	0.867
	Sci-Math	110	3.22	0.34		

As seen in Table 3, there was a significant difference between teachers' scientific thinking skills according to the branch variable only in Information gathering/organizing [$t(214) = 1.53$, $p<0.05$). On the other hand, no significant difference was found in Critical/scientific thinking, Creative/scientific thinking, Problem solving/scientific thinking and the whole scale according to the branch factor. In terms of collecting/organizing information, it was observed that science and mathematics teachers had higher mean scores compared to their colleagues in other branches. In order to determine whether there was a significant difference between teachers' professional seniority and their perceptions of scientific thinking skills levels, the distribution of teachers' responses to the scale items was determined and analysis of variance was applied to the mean scores. The results of the analysis of variance

are shown in Table 4.

Table 4. Comparison of Teachers' Scientific Thinking Skills Scale Scores According to Professional Seniority Variable

Scientific Thinking Skills	Professional Experience	N	Mean	Std. Deviation	F	P
Critical/scientific thinking	0-5 Years	42	2.86	0.32	7.315	0.000
	6-10 Years	53	2.85	0.22		
	11-19 Years	67	2.71	0.24		
	20 Years – up	52	2.67	0.31		
Creative/scientific thinking	0-5 Years	42	3.23	0.90	3.751	0.012
	6-10 Years	53	2.64	1.04		
	11-19 Years	67	2.71	0.88		
	20 Years - up	52	2.75	0.94		
Problem solving/scientific thinking	0-5 Years	42	3.35	0.62	4.049	0.008
	6-10 Years	53	3.45	0.55		
	11-19 Years	67	3.25	0.50		
	20 Years - up	52	3.11	0.47		
Collecting/organizing information	0-5 Years	42	4.06	0.53	1.801	0.148
	6-10 Years	53	4.15	0.63		
	11-19 Years	67	3.90	0.61		
	20 Years - up	52	3.97	0.67		
Scientific Thinking Average	0-5 Years	42	3.38	0.35	7.010	0.000
	6-10 Years	53	3.27	0.37		
	11-19 Years	67	3.15	0.27		
	20 Years - up	52	3.11	0.26		

As seen in Table 4, significant differences were observed in the mean scores of teachers in different seniority groups for Critical/Scientific Thinking, Creative/Scientific Thinking, Problem Solving/Scientific Thinking and Scientific Thinking skills ($p<0.05$). According to the results of the Tukey test conducted to find out between which professional seniority levels the difference between the scientific thinking skill levels of the teachers was between, it was determined that the scientific thinking skill levels of the teachers with a professional seniority of 5 years or less and 6-10 years were significantly higher than their colleagues with a professional seniority of 11 years or more. However, no significant difference was found in the 'gathering/organizing information' dimension of the scale according to the professional seniority variable.

Discussion and Conclusion

In this study, the relationships between professional experience and scientific thinking skills of teachers working in Kazakhstan were analyzed. In the study, which was carried out with the comparative survey model, one of the

quantitative research models, participant teachers' perceptions of scientific thinking skills were measured with a rating scale. According to the findings of the study, teachers' 'Critical/scientific thinking' and 'Creative/scientific thinking' skills were found to be low, 'Problem solving/scientific thinking' skills were found to be medium, and Information gathering/organizing skills were found to be high in terms of the four dimensions of the scientific thinking scale. In general, it is seen that the teachers in the research sample have a moderate level of scientific thinking skills. It can also be said that teachers and their evaluations have a special importance due to the reasons such as teachers being the professionals of education and being at the center of teaching practices.

As it is known, teachers are professional people who are trained through an education process that includes special field knowledge, general culture and pedagogical formation competencies to carry out teaching work in planned educational institutions. However, there are research findings that thinking skills training is insufficient within this formation education. On the other hand, one of the important requirements of the teaching profession is that teachers should be open to development and change (Kıncal, 2004; Çelikkaya, 2009). For this reason, people who are engaged in the teaching profession should constantly renew themselves professionally. As a matter of fact, one of the main responsibilities of teachers is to ensure that they and their students keep pace with scientific and technological developments and social changes on the basis of scientific method and to lead this situation (Çalışkan, 2006; Kuhn, 1993; Narode, 1987; Reif & Scott, 1999). In order for teachers to keep up with development and change, they must first have scientific thinking skills, be prone to research knowledge and skills, contribute to research with their thoughts and actions, and have a positive attitude towards research and researchers. For this reason, determining teachers' scientific thinking skills and their thoughts and attitudes towards scientific processes, and taking measures to eliminate these problems if there is a situation that should not be in this regard, can be considered as an important necessity for both those who carry out the teaching profession and researchers conducting research in educational sciences.

Another sub-problem addressed in the study is the relationship between teachers' gender and their scientific thinking skills. According to the analyses, significant differences were found between teachers' scientific thinking skills in the dimension of critical/scientific thinking, one of the dimensions of emotional scientific thinking, according to gender. It was observed that male teachers had higher levels of critical/scientific thinking skills compared to their female colleagues. These findings are similar to the findings of the studies conducted by Dori et al. (2018), Göktürker (2015), Kahle (2004), Piraksa, Srisawasdi, & Koul (2014), Ramdani et al. (2021), Yenilmez, Sungur & Tekkaya (2005). In the study conducted by Ramdani et al. (2021), significant differences were also observed in the development of critical thinking skills of male and female participants. One of them was that males responded faster and had higher self-confidence in problem solving based on the scientific method compared to females. According to Kahle (2004), the gender gap in science varies by discipline and is particularly pronounced in physics, mathematics and biology where the scientific method is actively used. Furthermore, the researcher argued that educators do not adequately address gender issues and that the lack of gender equitable teaching approaches can leave girls behind in terms of thinking skills and scientific literacy.

Another sub-problem sought to be answered in the research is whether there is a difference in scientific thinking skills of teachers according to their branches. According to the findings of the study, no significant difference was

found in critical/scientific thinking, creative/scientific thinking, problem solving/scientific thinking and the whole scale according to the branch factor. On the other hand, in the information gathering/organizing dimension of the scale, science and mathematics teachers achieved higher levels compared to their colleagues in other branches. These findings are similar to the findings of studies conducted by Al-Zoubi & Al-Salam (2009), Birgili (2015), Göktürker (2015), Yenilmez & Yolcu (2007). According to Yenilmez and Yolcu (2007), it is seen that teachers' contributions to the development of thinking in students differ in terms of the institutions they graduated from. This difference was due to the fact that teachers graduated from the Faculty of Education encouraged thinking skills more in the lessons, and this result can be attributed to the fact that the teachers graduated from the Faculty of Education in the sample are the new generation and effective thinking skills are among the current issues in recent years.

The last sub-problem sought to be answered in the research is whether there is a difference in teachers' scientific thinking skills according to their professional seniority and experience. According to the findings of the study, significant differences were found in the mean scores of teachers with different seniority in Critical/Scientific Thinking, Creative/Scientific Thinking, Problem Solving/Scientific Thinking and Scientific Thinking skills. According to further analysis, it was found that the scientific thinking skill levels of teachers with 10 years or less professional seniority were significantly higher than their colleagues with 11 years or more professional seniority. These findings are similar to the findings of the studies conducted by Göktürker (2015) and Yenilmez and Yolcu (2007). This result may be due to the fact that young teachers have more knowledge about new orientations in education such as critical thinking, reflective thinking, creative thinking, learning styles, multiple intelligence theory, brain-based teaching, problem-based teaching, etc., which have been put forward and intensively studied in the last decades. In Yorulmaz "s (2004) study, it was concluded that the fact that teachers did not take a Thinking Education course and inadequate in-service training were obstacles to scientific thinking. In Güney's (2008) study, it was concluded that micro-teaching is an application that improves teachers" thinking skills. According to this, it can be said that there is a deficiency in the education that pre-service teachers receive for the profession. In this case, teachers' knowledge about thinking skills can be increased and qualified practices that improve scientific thinking skills can be used.

One of the conclusions that emerges from many studies is that for effective teaching, the teacher needs to activate scientific thinking skills in the classroom. The teacher's role should be to examine the classroom environment, learning activities, student qualities and help students develop their scientific and creative thinking skills based on interpretation. In order for the teacher to be effective in this regard, he/she should have scientific thinking skills, create a creative classroom environment, solve the problems that students will encounter and ensure that they encounter problems in advance. Considering the role of the teacher in education, some of the behaviors and teacher characteristics exhibited by the teacher can prevent or support the development of thinking skills. Determining the teacher characteristics that prevent the development of scientific thinking skills and examining them with different modeled studies will make important contributions to the field. It is recommended that seminars, workshops and in-service training programs should be organized to improve teachers' scientific thinking skills. In the study, it was observed that teachers' scientific thinking skills were at a low level as their professional seniority increased. In this context, it is recommended that teachers should be assigned to projects that will

contribute to the development of research methodology, scientific method and scientific thinking skills in their professional careers. This study was conducted with quantitative methods and techniques. In future studies, it is recommended to study teachers' perceptions of scientific thinking skills with qualitative methods and to test the development of these skills with experimental methods. Finally, the development of teachers' scientific thinking skills can be improved by emphasizing practices that will improve teachers' scientific thinking skills in teacher training institutions.

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