Examining the scientific literacy of preschool teachers

Gülşah Günşen [iD][1], **Tuğba Kontaş Azaklı** [iD][2], **Gülden Uyanık** [iD][3]

[1] Department of Preschool Education, Education Faculty, Trakya University, Edirne, Türkiye; [2] Department of Preschool Education, Education Faculty, Ordu University, Ordu, Türkiye; [3] Department of Preschool Education, Education Faculty, Marmara University, İstanbul, Türkiye

ABSTRACT

This study aims to examine the scientific literacy levels and opinions of preschool teachers using a concurrent mixed methods approach. The quantitative study included 481 preschool teachers across Turkey, while the qualitative study involved in-depth interviews with 23 teachers. The quantitative results indicated that preschool teachers' scientific literacy levels did not significantly vary based on gender, age, or years of experience. However, significant differences were observed concerning educational level, scientific journal subscriptions, and participation in scientific projects. The qualitative findings revealed that teachers perceive scientific literacy as the ability to understand scientific concepts, apply them in daily life, and foster children's curiosity. More than half of the teachers did not consider themselves scientifically literate, highlighting a need for professional development in integrating science into early childhood education. The study suggests that enhancing teachers' scientific literacy could foster children's curiosity and technological integration in preschool settings.

CORRESPONDENCE

Tuğba Kontaş Azaklı

✉

Introduction

The preschool period is a time when children are curious, inquisitive, and begin to question, and it is important to provide an educational environment where children will be introduced to scientific activities (Trundle & Saçkes, 2015). Based on research, it can be said that the knowledge children gain during the preschool period, as expressed by the ecological systems theory, positively influences their academic success in later life (Bronfenbrenner & Morris, 2006; Sylva et al., 2013). Children's learning is also dependent on the educational opportunities provided, in addition to initiating and sustaining their learning processes and motivation (Barenthien et al., 2020). The key individuals in providing this educational support are preschool teachers (Ünal & Akman, 2006), and the individual characteristics, professional knowledge and attitudes, pedagogical content knowledge, and scientific literacy levels of preschool teachers directly affect the educational process (Gropen et al., 2017; McCray & Chen, 2012; Saçkes, Trundle & Bell, 2013; Siraj-Blatchford et al., 2002). Recent studies indicate that preschool teachers who are proficient in scientific literacy can significantly enhance children's inquiry skills and problem-solving abilities through inquiry-based learning approaches (Sepúlveda-Vallejos et al., 2023; Kurniah, 2023).However, it is also observed that the scientific knowledge levels of preschool teachers are lower than those of teachers in other fields (Garbett, 2003; Kallery & Psillos, 2001). This gap highlights the need for continuous professional development to improve teachers' scientific literacy, as it is essential for implementing innovative teaching methods that foster children's curiosity and engagement in scientific concepts (Cadime, 2024; Zhao, 2024).

The concept of scientific literacy was first introduced by Hurd in 1958 (Hurd, 1958). Miller (1983) discusses the concept of scientific literacy in three fundamental dimensions: understanding the nature of science, knowledge of science content, and understanding the impact of science on society. Scientifically literate individuals, as defined by Laugksch (2000), are those who possess a basic understanding of scientific concepts, can comprehend how scientists work, have an understanding of the nature of science,

comprehend the relationship between science and society, and understand the difference between science and technology. When considering the definition of scientific literacy as well as the characteristics of scientifically literate individuals, it becomes apparent that scientific literacy is not only associated with scientific knowledge but also with scientific attitudes (Demirbaş & Yağbasan, 2006). In the literature, scientific literacy is often examined in relation to its integration with technology to create broader societal impacts (Autieri, Amirshokoohi, & Kazempour, 2016). Additionally, Chatila (2016) emphasizes the use of biographical recounts in enhancing scientific literacy, particularly among pre-service primary science teachers, highlighting its effectiveness in fostering positive attitudes towards science. In fact, a study conducted by Bartan (2020) found that an increase in the basic level of scientific literacy among preschool teacher candidates led to the development of a positive scientific attitude. Therefore, the importance of the scientific literacy levels of preschool teachers becomes evident in the development of scientific literacy and the cultivation of positive attitudes towards science among preschool children. Scientific literacy is included in the educational programs of many countries, such as the United States, Finland, Australia, and South Korea, to foster critical thinking and problem-solving skills among students (Tekin, Aslan, & Yağız, 2016; Bybee & Fuchs, 2006). In the context of Turkey, the preschool education curriculum has been recently updated to align with both the revised Preschool Education Program (2023) and the "Turkey Century Maarif Model" (2024). These two programs, currently being implemented concurrently, emphasize fostering scientific literacy skills among preschool children by integrating achievements and indicators that encourage inquiry-based learning, scientific observation, and critical thinking. The 2023 Preschool Education Program focuses on promoting children's curiosity and scientific exploration through hands-on activities and experiential learning (MEB, 2023). Meanwhile, the 2024 Turkey Century Maarif Model expands on these goals by including competencies such as classification, prediction, and conducting experiments, which are crucial for developing early scientific process skills (MEB, 2024). However, it is observed in the literature that preschool teachers face difficulties in utilizing this list of concepts when planning science activities (Akcanca, Gürler, & Alkan, 2017; Dağlı & Dağlıoğlu, 2020; Gezgin & Kılıç, 2015; Orhan, 2019). Therefore, the ways in which children understand science in their daily lives are directly dependent on preschool teachers' accurate understanding and knowledge of science (Lind, 1999) and, consequently, their scientific literacy.

When the literature is examined, it is found that a limited number of studies have been conducted to determine the scientific literacy levels of preschool teachers (Gropen et al., 2017; Pereira, Rodrigues, & Vieira, 2020). However, no research has been found that thoroughly investigates the scientific literacy of preschool teachers, both quantitatively and qualitatively. In a study conducted by Bartan (2020), the basic scientific literacy levels and scientific attitudes of preschool teacher candidates were compared, and it is observed in the literature that research on this topic is generally limited to science teacher candidates, elementary teacher candidates, and social studies teacher candidates (Bacanak, 2002; Huyugüzel Çavaş, 2009; Lee, 2001; Tekin, 2013; Ulutaş, 2009; Yetişir, 2007; Yolagiden, 2017). Therefore, the importance of examining the scientific literacy of preschool teachers in the field becomes evident. Considering that the scientific literacy levels and opinions of preschool teachers about scientific literacy will be crucial in the development of individuals with high scientific literacy in the future, it is believed that the results of this study will shed light on educational arrangements that can be made within the scope of improving early childhood education. Based on this point, the aim of this study is to examine the scientific literacy of preschool teachers and their opinions about scientific literacy.

Method

Model of the research

In this research, which examines the scientific literacy levels of preschool teachers and their views on scientific literacy, a mixed research approach was used to collect quantitative and qualitative data (Creswell, 2015). As for the design, a convergent/parallel mixed methods research design was used, where quantitative and qualitative data were collected simultaneously with equal status (Christensen, Johnson & Turner, 2015; Creswell & Plano Clark, 2015; Toraman, 2021). The reason for choosing the concurrent mixed methods approach in this study is to interpret the research findings based on the results obtained by collecting quantitative and qualitative data together with a holistic approach.

Participants

Quantitative participants

The quantitative study of the research consists of 481 preschool teachers from various regions of Turkey who volunteered to participate in the research during the 2022–2023 academic year. The characteristics of the study group are shown in Table 1.

Table 1. Demographic characteristics of the participant in the research

Demographic Characteristics		f	%
Gender	Female	424	88,15
	Male	57	11,85
Age	21–25	32	6,65
	26–30	89	18,50
	31–35	101	20,99
	36–40	121	25,16
	41–45	79	16,44
	46–50	37	7,69
	51 and over	22	4,57
Type of School Graduated from	Pre-school teaching	331	68,81
	Child Development	109	22,66
	Other (Open Education, Branch)	41	8,53
Education level	Associate Degree	89	18,50
	Bachelor's Degree	357	74,22
	Master's Degree	35	7,28
Professional seniority	1–5 year	123	25,57
	6–10 year	120	24,95
	11–15 year	121	25,16
	16–20 year	88	18,30
	21 year and over	29	6,03
Scientific Journal Subscription–Tracking	Yes	43	8,94
	No	438	91,06
Scientific Project Participation	Yes	63	13,10
	No	418	86,90

When Table 1 is examined, it can be seen that 88.15% (f=424) of preschool teachers are female, 11.85% (f=57) are male, 6.65% (f=32) are aged 21–25, 18.50% (f=89) are aged 26–30, 20.99% (f=101) are aged 31–35, 25.16% (f=121) are aged 36–40, 16.44% (f=79) are aged 41–45, 7.69% (f=37) are aged 46–50, and 4.57% (f=22) are aged 51 and above. It is observed that 68.81% (f = 331) have a bachelor's degree in preschool teaching, 22.66% (f = 109) are graduates of child development programs, and 8.53% (f = 41) are graduates of other programs (distance education, specialization). In terms of educational levels, 74.22% (f = 357) have a bachelor's degree, 18.50% (f = 89) have an associate's degree, and 7.28% (f = 35) have a master's degree. In terms of professional seniority, 25.57% (f = 123) have 1–5 years of experience, 24.95% (f = 120) have 6–10 years of experience, 25.16% (f = 121) have 11–15 years of experience, 18.30% (f = 88) have 16–20 years of experience, and 6.03% (f = 29) have 21 years or more of experience. When the subscription and follow-up of scientific journals are examined, it is found that 91.06% (f = 438) do not have a subscription or follow-up, while 8.94% (f = 43) have a subscription or follow-up. In terms of participation in scientific projects, it is observed that 86.90% (f = 418) do not participate, while 13.10% (f = 63) do.

Qualitative participants

A total of 23 preschool teachers, who also expressed their desire to participate in the interview while filling out the quantitative measurement tools, form the qualitative study group of the research out of 481 preschool teachers who want to participate in the study voluntarily. In the qualitative study group, 91.30% (f = 21) of the preschool teachers are female, 8.70% (f = 2) are male, all teachers (f = 23) are graduates of the preschool teaching undergraduate program, 65.22% (f = 15) have a bachelor's degree, 34.78% (f = 8) have a master's degree, and all teachers (f = 23) have been teaching for 11–15 years.

Data collection process and data collection tools

Before starting the data collection process, the necessary ethical committee application for the research was submitted to the Ethics Committee for Social and Human Sciences Research of Trakya University. Following the approval, granted during their meeting on 22.12.2021 with decision number 10/30, the measurement tools were transferred to an online platform and distributed nationwide across Turkey. Pre-school teachers who volunteered to participate in the research first filled out the research consent form, personal information form, and measurement tools online. The data collection process for quantitative data started on 27.12.2021 and ended on 11.02.2022. The implementation of the interview form was carried out by contacting pre-school teachers who filled out the quantitative forms separately, and interviews were conducted online from February 14, 2023, to February 25, 2023.

Test of basic scientific literacy

Test of Basic Scientific Literacy was developed by Laugksch and Spargo (1996) and adapted into Turkish by Turgut (2005). The scale consists of two subscales: the nature of science and science-technology-society, with 38 items rated on a 5-point Likert scale. When evaluating responses to the scale, the intervals "strongly

disagree" (1.00-1.80), "disagree" (1.81-2.60), "undecided" (2.61-3.40), "agree" (3.41-4.20), and "strongly agree" (4.21-5.00) are used for interpretation. The Cronbach's alpha values for the subscales of the scale are 0.88 for the nature of science subscale and 0.92 for the science-technology-society relationship subscale. In this study, the values were calculated as 0.86 for the nature of science subscale, 0.89 for the science-technology-society relationship subscale, and 0.88 for the entire scale.

Preschool teachers' semi-structured interview form for determining their views on scientific literacy

The semi-structured interview form developed within the scope of the research consists of four open-ended questions. Prior to preparing the interview form, categories were created based on the literature review (Duban, 2010; Karademir-Alkan, 2012; Kızılay & Kırmızıgül, 2020; Laugksch & Spargo, 1996; Turgut, 2005) on scientific literacy. Research questions were developed based on these categories and sent to an expert in science education and an expert in preschool education for expert opinions. In order to ensure the reliability of the measurement tool, experts were asked to review the questions in the interview form as appropriate/not appropriate-recommendation. One of the methods used to calculate inter-rater agreement for the opinions given by the two experts on the interview form is the Kappa coefficient (Stemler, 2004). Since two experts were consulted for the interview form, Cohen's Kappa test was applied to calculate the agreement percentage (McHugh, 2012), and it was determined that the kappa value for the interview form was k=0.92. According to this result, it was found that the experts who were consulted for the interview form were in almost perfect agreement (Cohen, 1960; McHugh, 2012), and the final version of the interview form was prepared based on the recommendations provided by the experts. In the final version of the interview form, which was prepared based on expert opinions, the following questions were directed to preschool teachers: "What do you think scientific literacy is?," "Do you consider yourself scientifically literate? If yes/no, could you explain how you perceive it?," "What are the characteristics of a scientifically literate individual in your opinion?," "What are the potential benefits of being scientifically literate for preschool education in your opinion?" A total of 13 preschool teachers who wanted to participate in the interview were planned to have face-to-face interviews with the researchers because they were in the same city center. Interviews with the other 10 preschool teachers were conducted individually online at the time intervals they specified. Each interview with a teacher lasted approximately 20 minutes.

Data analysis

Analysis of quantitative data

The Test of Basic Scientific Literacy was administered to preschool teachers to determine whether there is a statistically significant difference in the scientific literacy levels of preschool teachers based on gender, age, type of school graduated from, educational level, professional seniority, subscription-following of scientific journals, and participation in scientific projects, in the analysis of the nice data. The obtained data was examined to see if it followed a normal distribution using a statistical software. Since the sample size in the study group was 30 or more, the Kolmogorov-Smirnov normality test was used (Büyüköztürk, 2014). The results of the normality test are shown in Table 2.

Table 2. Kolmogorov-Smirnov normality test results of research data

Scale	Scale Sub-Dimensions	Statistic	df	Sig.
Test of Basic Scientific Literacy	Nature of science	.071	481	.000*
	Science-technology-society	.086	481	.000*
	Scale total	.086	481	.000*

When Table 2 was examined, it was observed that the research data did not follow a normal distribution (p<0.05), and non-parametric tests were used in the study.

Analysis of qualitative data

In the study, qualitative content analysis, which includes interpretation, classification, and analysis stages in line with the constructivist research paradigm, was used to present the data without any numerical tools (Altunışık et al., 2015; Kuckartz, 2014). In order to prevent power imbalance between the researcher and participant, establish an egalitarian position, and ensure the validity and reliability of the research, a collaborative research approach was used among the researchers, as suggested by Glesne (2012). Additionally, throughout the process, the researchers adopted the strategy of researcher reflexivity. In this regard, the researchers continued the process by constantly monitoring their own assumptions and biases during the examination, coding, analysis, and report writing processes (Creswell & Miller, 2000). It is believed that researcher reflexivity contributes to the internal validity (credibility), consistency, and confirmability of the research.

The analysis of research data started with the creation of a codebook. In the coding process, a deductive approach was used to create a closed codebook based on previous research and theoretical background.

However, in the process of codebook creation, an inductive approach was also used, and two transcripts corresponding to 10-20% of the number of participants were randomly selected from the data set and coded separately by two coders. In this process, open coding, axial coding, and selective coding were carried out using Strauss and Corbin's (1990) inductive coding paradigm. The coding process was conducted by opening separate Excel files for codes, definitions, and examples, and later one of the researchers merged the two code tables into a single Excel file. During the creation of the codebook, a total of 14 subcodes were assigned by the coders, and there was disagreement in two codes (under the category of self-perceived literacy). The intercoder agreement percentage was calculated as 86%. Miles and Huberman (1994) state that an agreement percentage of 70% or higher is acceptable during the creation of a codebook. At this point, it was observed that the agreement between the coders was sufficient in the process of codebook creation, and in the points of disagreement, discussions were held and a consensus was reached to create the final codebook. After the codebook was created, the researchers individually coded the main data according to the codebook and then came together to discuss and finalize the process for the emerging new codes. In the final stage, the data consisted of four categories and 14 codes, including six subcodes. To examine the reliability of the study, coding reliability was examined by coding and categorizing the data by the researchers, and the coding percentage was calculated. The agreement between the researchers was calculated by dividing the number of agreements by the total number of agreements and disagreements. The coding agreement percentage among the researchers was found to be 86%. A coding percentage above 80% indicates the reliability of the research (Büyüköztürk et al., 2012; Miles et al., 2020; Patton, 2014; Yıldırım & Şimşek, 2013). The following formula was used to calculate the coding percentage: Agreement percentage = Number of agreements / (Number of agreements + Number of disagreements). The number of agreements in the study was 12, and the number of disagreements was 2. According to the formula for agreement percentage, the agreement percentage in the study was calculated as 12 / (12+2) = 0.86.

Findings

Quantitative findings on the basic scientific literacy levels of preschool teachers

In order to determine the basic scientific literacy levels of preschool teachers, Mann Whitney U Test was applied for the variables of gender, scientific journal subscription, and participation in scientific projects, and Kruskal-Wallis H Test was applied for the variables of age, type of graduated school, education level, and professional seniority.

The results obtained from the basic scientific literacy test of preschool teachers are shown in Table 3.

Table 3. Results obtained in the basic scientific literacy test of preschool teachers

Scale Sub-Dimensions	N	X̄	ss	Min	Max
Nature of science	481	3.35	0.56	1.49	5.00
Science-technology-society	481	3.17	0.53	1.42	4.76
Scale total	481	3.29	0.54	1,53	4.81

When Table 3 is examined, it can be seen that the scores obtained by preschool teachers from the basic scientific literacy test correspond to the "undecided" range in terms of the sub-dimensions of the nature of science (mean=3.35, sd=0.56) and science-technology-society relationship (mean=3.17, sd=0.53). It is also observed that the literacy levels for the entire scale (mean=3.29, sd=0.54) correspond to the "undecided" range.

The Mann-Whitney U test results regarding the significant differences in the basic scientific literacy levels of preschool teachers according to the gender variable are shown in Table 4.

Table 4. Mann-Whitney U test results regarding the basic scientific literacy test according to the gender variable

Scale Sub-Dimensions	Gender	N	X̄	Rank Average	Rank Total	U	p
Nature of science	Female	424	3.37	316.31	146916.00		
	Male	57	3.29	312.28	52468.00	37283.000	.752
	Total	481	3.33				
Science-technology-society	Female	424	3.16	316,14	146271.50		
	Male	57	3.11	315.51	52032.50	38825.500	.949
	Total	481	3.14				
Scale total	Female	424	3.27	316.12	146405.00		
	Male	57	3.20	315.41	51991.00	38785.00	.952
	Total	481	3.24				

When Table 4 is examined, it can be seen that there is no significant difference between the basic scientific literacy levels of preschool teachers in terms of the nature of science (U=37283.000; p=.752; p>0.05), the relationship between science-technology-society (U=38825.500; p=.949; p>0.05), and the total scale

(U=38785.00; p=.952; p>0.05) based on gender. According to these results, there is no statistically significant difference between female preschool teachers and male preschool teachers in terms of their basic scientific literacy levels.

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to the age variable, the results of the Kruskal–Wallis H test are presented in Table 5.

Table 5. Kruskal–Wallis H test results for the basic scientific literacy test according to the age variable

Scale Sub-Dimensions	Age	N	X̄	Rank Average	Sd.	X²	p
Nature of science	21–25	32	3.24	277.74	5	9.457	.225
	26–30	89	3.39	321.89			
	31–35	101	3.46	342.85			
	36–40	121	3.31	305.13			
	41–45	79	3.45	329.39			
	46–50	37	3.25	271.33			
	Total	481	3.35				
Science-technology-society	21–25	32	3.11	279.62	5	9.141	.234
	26–30	89	3.19	321.14			
	31–35	101	3.19	312.79			
	36–40	121	3.15	300.62			
	41–45	79	3.21	329.08			
	46–50	37	3.15	301.37			
	Total	481	3.19				
Scale total	21–25	32	3.18	276.96	5	8.898	.259
	26–30	89	3.32	320.49			
	31–35	101	3.36	328.67			
	36–40	121	3.24	303.76			
	41–45	79	3.33	323.13			
	46–50	37	3.22	279.22			
	Total	481	3.28				

When Table 5 is examined, it can be seen that there is no significant difference in the basic scientific literacy levels of preschool teachers in terms of the nature of science dimension based on age (X2=9.457; p=.225; p>0.05), no significant difference based on the science-technology-society dimension (X2=9.141; p=.234; p>0.05), and no significant difference in the total scale based on age (X2=8.898; p=.259; p>0.05).

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to the type of school they graduated from, the results of the Kruskal–Wallis H test are presented in Table 6.

Tablo 6. Kruskal–Wallis H test results for the basic scientific literacy test according to the graduated school type

Scale Sub-Dimensions	Type of School Graduated from	N	X̄	Rank Average	Sd.	X²	p
Nature of science	Pre-school teaching	331	3.39	310.91	2	0.043	.898
	Child Development	109	3.27	315.02			
	Other (Open Education, Branch)	41	3.18	312.41			
	Total	481	3.28				
Science-technology-society	Pre-school teaching	331	3.38	369.52	2	5.219	.069
	Child Development	109	3.17	313.11			
	Other (Open Education, Branch)	41	3.01	296.91			
	Total	481	3.19				
Scale total	Pre-school teaching	331	3.35	350.52	2	1.523	.434
	Child Development	109	3.27	313.59			
	Other (Open Education, Branch)	41	3.19	292.69			
	Total		3.27				

When Table 6 is examined, it can be seen that there is no significant difference in the basic scientific literacy levels of preschool teachers in terms of the nature of science dimension based on the type of school they graduated from (X2=0.043; p=.898; p>0.05), no significant difference based on the science-technology-society dimension (X2=5.219; p=.069; p>0.05), and no significant difference in the total scale based on the type of school they graduated from (X2=1.523; p=.434; p>0.05).

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to their educational level, the results of the Kruskal–Wallis H test are presented in Table 7.

Table 7. Kruskal–Wallis H test results for the basic scientific literacy test according to the education level variable

Scale Sub-Dimensions	Education level	N	X̄	Rank Average	Sd.	X²	p
Nature of science	Associate Degree	89	3.13	243.21	2	9.627	.008*
	Bachelor's Degree	357	3.26	315.69			
	Master's Degree	35	3.39	382.41			
	Total	481	3.26				
Science-technology-society	Associate Degree	89	3.11	254.82	2	4.038	.133
	Bachelor's Degree	357	3.17	313.11			
	Master's Degree	35	3.29	339.91			
	Total	481	3.19				
Scale total	Associate Degree	89	3.14	231.92	2	9.431	.009*
	Bachelor's Degree	357	3.31	313.59			
	Master's Degree	35	3.39	368.79			
	Total	481	3.28				

When Table 7 is examined, it is observed that there is a statistically significant difference in the basic scientific literacy levels of preschool teachers in the sub-dimension of the nature of science (X2=9.627; p=.008; p<0.05) and in the total scale (X2=9.431; p=.009; p<0.05) according to their educational level. To determine which two groups this difference is between, a Bonferroni multiple comparison test was conducted after the Kruskal-Wallis H test. The difference in the sub-dimension of the nature of science was found between preschool teachers with an associate's degree and those with a master's degree, with preschool teachers with a master's degree having a higher level of scientific literacy towards the nature of science. The difference in the total scale was found among preschool teachers with an associate's degree, a bachelor's degree, and a master's degree. When the total scale was examined, it was determined that preschool teachers with an associate's degree had a lower level of scientific literacy compared to preschool teachers with a bachelor's or a master's degree. The scientific literacy levels of preschool teachers with a bachelor's degree were higher than those of preschool teachers with an associate's degree. Additionally, the scientific literacy levels of preschool teachers with a master's degree were higher than those of preschool teachers with an associate's degree. There is no significant difference in the sub-dimension of Science-Technology-Society relationship in the basic scientific literacy test of preschool teachers according to their educational level (X2=4.038; p=.133; p>0.05).

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to their professional seniority, the results of the Kruskal-Wallis H test are shown in Table 8.

Table 8. Results of the Kruskal-Wallis H test for the basic scientific literacy test according to professional seniority variable

Scale Sub-Dimensions	Professional seniority	N	X̄	Rank Average	Sd.	X²	p
Nature of science	1-5 year	123	3.29	287.10	4	8.643	.187
	6-10 year	120	3.51	343.69			
	11-15 year	121	3.40	329.01			
	16-20 year	88	3.33	304.63			
	21 year and over	29	3.51	306.91			
	Total	481					
Science-technology-society	1-5 year	123	3.15	301.89	4	9.294	.153
	6-10 year	120	3.29	317.11			
	11-15 year	121	3.18	318.72			
	16-20 year	88	3.11	298.48			
	21 year and over	29	3.22	324.71			
	Total	481					
Scale total	1-5 year	123	3.24	292.89	4	7.833	.251
	6-10 year	120	3.37	313.56			
	11-15 year	121	3.29	327.03			
	16-20 year	88	3.21	301.12			
	21 year and over	29	3.30	290.39			
	Total	481					

When Table 8 is examined, it is observed that there is no significant difference in the basic scientific literacy levels of preschool teachers in the sub-dimension of the nature of science according to their professional seniority (X2=8.643; p=.187; p>0.05), in the dimension of Science-Technology-Society relationship according to their professional seniority (X2=9.294; p=.153; p>0.05), and in the total scale according to their professional seniority (X2=7.833; p=.251; p>0.05).

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to the variable of scientific journal subscription-following, the results of the Mann-Whitney U test are shown in Table 9.

Table 9. Results of the Mann-Whitney U test for the basic scientific literacy test according to scientific journal subscription-following variable

Scale Sub-Dimensions	Scientific Journal Subscription-Tracking	N	X̄	Rank Average	Rank Total	U	p
Nature of science	Yes	43	3.39	343.31	57788.50		
	No	438	3.12	331.28	141607.49	34191.500	.020*
	Total	481					
Science-technology-society	Yes	43	3.16	325,14	150571.50		
	No	438	2.97	313.11	48824.50	34628.500	.035*
	Total	481					
Scale total	Yes	43	3.24	332.12	147405.00		
	No	438	3.03	321.31	53991.00	34785.000	.025*
	Total	481					

p<0.05

When Table 9 is examined, it is observed that there is a statistically significant difference in the basic scientific literacy levels of preschool teachers according to the variable of scientific journal subscription-following in the sub-dimension of the nature of science (U=34191.500; p=.020; p<0.05), in the dimension of Science-Technology-Society relationship (U=34628.500; p=.035; p<0.05), and in the total scale (U=34785.00; p=.025; p<0.05). The arithmetic averages of this differentiation show that it is in favor of scientific journal subscription-following in the sub-dimension of the nature of science, the dimension of Science-Technology-Society, and the total scale.

To determine whether there is a significant difference in the basic scientific literacy levels of preschool teachers according to the variable of participation in scientific projects, the results of the Mann-Whitney U test are shown in Table 10.

Table 10. Results of the Mann-Whitney U test for the basic scientific literacy test according to participation in scientific projects variable

Scale Sub-Dimensions	Scientific Project Participation	N	X̄	Rank Average	Rank Total	U	p
Nature of science	Yes	63	3.23	402.89	17826.50		
	No	418	3.09	309.33	1801669.50	9090.500	.001*
	Total	481					
Science-technology-society	Yes	63	3.31	423.03	18560.50		
	No	418	2.99	307.11	180833.50	8156.500	.000*
	Total	481					
Scale total	Yes	63	3.19	432.12	19124.00		
	No	418	2.97	307.31	180262.00	7695.000	.000*
	Total	481					

p<0.05

When Table 10 is examined, it is observed that there is a statistically significant difference in the basic scientific literacy levels of preschool teachers according to the variable of participation in scientific projects in the sub-dimension of the nature of science (U=9090.500; p=.001; p<0.05), in the dimension of Science-Technology-Society relationship (U=8156.500; p=.000; p<0.05), and in the total scale (U=7695.000; p=.000; p<0.05). The arithmetic averages of this differentiation show that it is in favor of participation in scientific projects in the sub-dimension of the nature of science, the dimension of Science-Technology-Society, and the total scale.

Findings on preschool teachers' views on scientific literacy

The findings obtained by coding the responses given by preschool teachers to the questions asked with the Semi-Structured Interview Form determining the views of preschool teachers on Scientific Literacy of Preschool Teachers are presented in Figure 1 in the form of a hierarchical code graph.
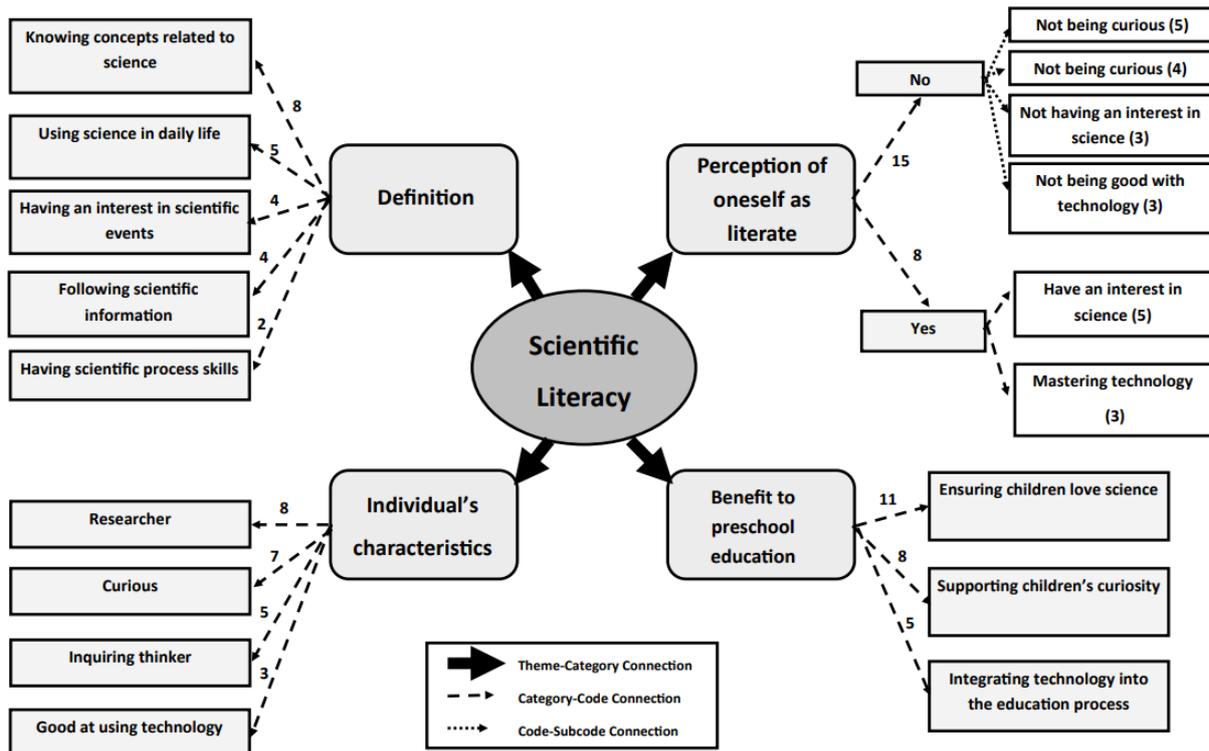
Figure 1. Hierarchical code graph representing preschool teachers' views on scientific literacy

When examining Figure 1, it can be seen that the responses of pre-school teachers to the concept of scientific literacy are categorized into four categories: the definition of scientific literacy, the characteristics of scientifically literate individuals, the perception of oneself as scientifically literate, and the benefits of scientific literacy in pre-school education. These categories consist of a total of 14 codes and six sub-codes.

Responses in the category of defining scientific literacy of preschool teachers

When the responses of preschool teachers in the category of defining scientific literacy were examined, it can be seen that eight teachers described scientific literacy as knowing scientific concepts, five teachers as being able to use science in daily life, four teachers as having an interest in scientific events, and four teachers as being able to follow scientific knowledge.

An example response in the code of knowing scientific concepts by preschool teachers was given by teacher Ö11 as follows:

> "...scientific literacy is knowing science and most things related to science..."

An example response in the code of being able to use science in daily life by preschool teachers was given by teacher Ö19 as follows:

> "...scientific literacy includes being able to use scientific knowledge in daily life..."

An example response in the code of having an interest in scientific events by preschool teachers was given by teacher Ö5 as follows:

> "...individuals who are interested in scientific events can be considered as scientifically literate individuals..."

An example response in the code of being able to follow scientific knowledge by preschool teachers was given by teacher Ö3 as follows:

> "...science is constantly evolving. Therefore, individuals who can keep up with and follow the flow of scientific knowledge within this rapid scientific progress are scientifically literate individuals..."

Responses of preschool teachers in the category of characteristics of scientifically literate individuals

When the responses of preschool teachers in the category of characteristics of scientifically literate individuals were examined, it was observed that eight teachers stated that scientifically literate individuals

are researchers, seven teachers described them as curious, five teachers identified them as inquisitive, and three teachers highlighted their proficiency in using technology.

One of the preschool teachers who defined scientifically literate individuals as researchers, teacher Ö8, provided the following example response:

> "...having a research-oriented mindset is what makes individuals scientifically literate..."

One of the preschool teachers who described scientifically literate individuals as curious, teacher Ö11, gave the following example response:

> "...scientifically literate individuals are curious..."

One of the preschool teachers who defined scientifically literate individuals as inquisitive, teacher Ö13, provided the following example response:

> "...questioning is inherent in science. However, most people struggle with questioning. Scientifically literate individuals, however, are individuals who can think critically..."

One of the preschool teachers who defined scientifically literate individuals as proficient in using technology, teacher Ö9, provided the following example response:

> "...science means technology. Individuals who can keep up with technology and use artificial intelligence in all areas are scientifically literate..."

Responses of preschool teachers in the category of perceiving themselves as scientifically literate

When the responses of preschool teachers in the category of perceiving themselves as scientifically literate were examined, it was observed that 15 teachers did not perceive themselves as scientifically literate, while eight teachers stated that they perceive themselves as scientifically literate. Among the preschool teachers who did not perceive themselves as scientifically literate, five stated that they do not perceive themselves as curious, four stated that they do not love science, three stated that they are not interested in science, and three teachers stated that they do not have a relationship with technology.

One of the preschool teachers who did not perceive themselves as curious and therefore not as scientifically literate, teacher Ö1, provided the following response:

> "...in daily life, I do not perceive myself as curious enough. I can immediately access the information I am looking for on my phone. I don't need to conduct research for this, and therefore I do not perceive myself as scientifically literate..."

One of the preschool teachers who did not perceive themselves as scientifically literate because they do not love science, teacher Ö13, provided the following response:

> "...scientific knowledge is changing rapidly, and sometimes our biases towards science also form. For example, during the pandemic, we trusted the BioNTech vaccine unconditionally based on science, but now it is emerging that it has many side effects. This situation prevents me from loving science, and therefore I am not a scientific reader or writer..."

One of the preschool teachers who did not perceive themselves as scientifically literate because they are not interested in science, teacher Ö2, provided the following response:

> "...in this period where artificial intelligence has become so integrated into our lives, we can access any information we want. Therefore, there is no need to have a separate interest in science, and therefore I do not think I am a scientific reader or writer..."

One of the preschool teachers who did not perceive themselves as scientifically literate because they have no relationship with technology, teacher Ö14, provided the following response:

> "...I have always struggled with technology. No matter how hard I try, I cannot use technology properly, which also shows that I am not a scientific reader or writer..."

Figure 2 shows that among the preschool teachers who perceive themselves as scientifically literate, five perceive themselves as such because they are interested in science, and three perceive themselves as such because they are proficient in technology.

One of the preschool teachers who perceive themselves as scientifically literate because they are interested in science, teacher Ö11, provided the following response:

> "...science is inherent in life, and understanding the world we live in is actually understanding science. Therefore, understanding many events we encounter in daily life and explaining them to

children is also related to understanding science. Therefore, I try to access scientific knowledge because I am curious about the events we encounter in daily life. Therefore, I perceive myself as scientifically literate..."

One of the preschool teachers who perceive themselves as scientifically literate because they are proficient in technology, teacher Ö9, provided the following response:

"...by using artificial intelligence tools, I can instantly access the answers to all the questions children ask me and provide them with answers. The fact that I use technology shows that I am a scientifically literate person..."

Responses of preschool teachers in the category of the benefits of scientific literacy in preschool education

When the responses of preschool teachers in the category of the benefits of scientific literacy in preschool education were examined, it was observed that 11 teachers stated that being scientifically literate will contribute to children loving science, eight teachers stated that it will support children's curiosity, and five teachers stated that it will enable the integration of technology into the educational process.

One of the preschool teachers who stated that scientific literacy will contribute to children loving science, teacher Ö8, provided the following example response:

"...a preschool teacher should be a teacher who loves science and is scientifically literate. Because we are the people children look up to after their families. Our love for science and acting in the light of science will also make them love and be interested in science. For example, when talking about diseases with children in the classroom, telling them to do what doctors say and recommend will teach them that they need to trust scientific knowledge..."

One of the preschool teachers who stated that scientific literacy will support children's curiosity, teacher Ö14, provided the following example response:

"...children are very curious during the preschool period. If I give an example from my classroom experience, when a child who ran into the classroom with excitement on a morning when there was fog said to me, "Teacher, we came without seeing anything today, these are clouds, I came from inside the clouds," I encouraged them to become even more curious and conduct research by saying, "This weather phenomenon is called fog, and now let's examine the weather conditions." If I had just said, "Okay," and listened to them, I would have hindered their curiosity. I am a scientifically literate teacher, and I will support my children in becoming scientifically literate without losing their curiosity..."

One of the preschool teachers who stated that scientific literacy will contribute to teachers being able to integrate technology into the educational process, teacher Ö16, provided the following example response:

"...I am not a teacher who is against the use of technological tools. On the contrary, I am aware of the importance of accessing good content and games and children playing. In our classroom, for example, I enable them to play many games related to various science concepts such as living-nonliving, similar-different, and the characteristics of living things by using Wordwall. I am supporting them to be both scientifically and technologically literate..."

Results and discussion

In this research, which examines the scientific literacy levels and views of preschool teachers about scientific literacy, it is observed that preschool teachers are "indecisive" in their scientific literacy levels. This result is also supported by research conducted on the basic scientific literacy level in the literature. Research conducted with primary school and science teacher candidates has revealed that the scientific literacy level is quite low in teacher candidates (Aymak, 2023; Bacanak, 2002; Čipková, et al., 2018; Huyugüzel Çavaş, 2009; Işık-Terzi, 2008; Özdemir, 2011; Öztaş, 2019; Yavuz, 2018). On the contrary, there are research results indicating that the scientific literacy levels of science teacher candidates, primary school teacher candidates, and social studies teacher candidates are high (Erbudak, 2021; Sultan, Henson & Fadde, 2018; Tekin, 2013; Ulutaş, 2009; Yolagiden, 2017). In a research conducted by Bartan (2020), it was determined that the scientific literacy levels of preschool teacher candidates are high. At this point, it is thought that the number of science-themed courses in the undergraduate programs of primary school and science teacher candidates will have an effect on their scientific literacy levels. In fact, in a research conducted by Önder, Sılay and Şenyiğit (2017), it was found that science teacher candidates had higher scientific literacy scores than preschool teacher candidates. It is thought that the reason for this difference between preschool teachers and teacher candidates may be that in the newly updated preschool teacher training program in Turkey, environmental education and STEM education courses have been added in addition to science

education courses, which allows preschool teacher candidates to have higher scientific literacy levels compared to previously graduated preschool teachers. Furthermore, considering the generational difference between teachers and teacher candidates, it is thought that preschool teacher candidates who will represent the new generation of teachers and individuals who make up Generation Z may have higher access to scientific knowledge due to their interest in scientific events and intensive use of technology. In fact, when the distribution of the study group is examined in this research, it is seen that the teachers mostly represent Generation Y. It is thought that the scientific literacy levels of preschool teachers who are mostly digital immigrants in this research, and who represent digital natives (Bassiouni & Hackley, 2014) who access information quickly using technology instead of books, may be low. The findings obtained from the interview form also support this result, as more than half of the preschool teachers stated that they do not consider themselves as scientifically literate.

As a result of the research, it was determined that the basic scientific literacy levels of preschool teachers do not differ according to gender, age, and professional seniority, but differ significantly according to educational level, scientific journal subscription/follow-up, and scientific project participation. The result that the scientific literacy of preschool teachers does not change according to the gender variable is also supported by the literature (Aymak, 2023; Göktepe, 2019; Huyugüzel Çavaş, 2009; Işık-Terzi, 2008; Tekin, Aslan & Yağız, 2016; Yetişir, 2007). On the contrary, there are research results indicating that the scientific literacy levels of preschool, primary school, and science teacher candidates differ according to gender (Bacanak, 2002; Bartan, 2020; Dombaycı & Ercan, 2017; Ulutaş, 2009; Yolagiden, 2017). The fact that preschool teachers are mostly female is a limitation for this research. At this point, it is thought that the results regarding whether there is a difference in scientific literacy levels according to the gender variable can be reached when normal distribution is achieved in the study group. Likewise, the fact that the majority of the preschool teachers who wanted to participate in the interview were female (21 female, 2 male) also constitutes a limitation of this research. It was found that out of the female preschool teachers who participated in the interview (n=21), only seven saw themselves as scientifically literate, while 14 did not see themselves as scientifically literate. Among the male preschool teachers (n=2), one saw himself as scientifically literate, while the other did not.

In the research, it was determined that the scientific literacy levels of preschool teachers differ significantly according to educational level, scientific journal subscription/follow-up, and scientific project participation. It is observed in the literature that as the educational level increases, the level of scientific literacy also increases (Erbudak, 2021; Karataş, et al., 2019). It is thought that receiving more educational support, having higher interest levels, and following scientific publications may be more effective in the development of basic scientific literacy levels. Research conducted in the literature also supports this view (Aymak, 2023; Chatila, 2016; Dombaycı & Ercan, 2017; Erbudak, 2021; Tatlı, 2017; Tunç Şahin, 2013; Turgut & Fer, 2006). However, in a research conducted by Göktepe (2019), it was found that the scientific literacy levels of science teachers did not change depending on their scientific journal subscriptions. At this point, it is thought that preschool teachers, despite not having received enough science-themed courses in their previous undergraduate programs, may have increased their scientific literacy levels through practices that will increase their scientific awareness, such as scientific journal subscriptions/follow-up and participation in scientific projects during their professional lives. Indeed, when the findings obtained from the interview form are examined, it is seen that preschool teachers define scientific literacy as knowing scientific concepts, being able to use science in daily life, having an interest in scientific events, and being able to follow scientific knowledge, and they state that scientific literate individuals are researchers, curious, questioning, and good at using technology. These results, which include the association of science with technology by preschool teachers in defining scientific literacy, also indicate that they have a concept confusion. When asked whether they consider themselves scientifically literate, three teachers (2 male, 1 female) stated that they consider themselves scientifically literate because they use technology well, while three teachers (3 female) stated that they do not consider themselves scientifically literate because they cannot use technology well. When asked about the benefits of scientific literacy in the preschool education process, five preschool teachers responded that it would enable children to love science, support their curiosity, and allow teachers to integrate technology into the educational process. At this point, if the definition of science is examined again, science refers to the whole of obtaining objective knowledge through previously defined methods using experiments and observations to understand the universe and the events within it (Osborne, 2023; Schwartz, Lederman & Enderle, 2023). Technology, on the other hand, is the applied form of the knowledge obtained from these methods for the use of people in various fields. In summary, while the purpose of science is to pursue knowledge for the sake of science, the purpose of technology is to meet people's needs and make their lives easier. In fact, these two areas are not separate; science and technology interact with each other and often the development of one area can trigger the other. While science can support technological developments, technology can also provide new opportunities for scientific research (Autieri, Amirshokoohi & Kazempour, 2016; Schwartz, Lederman &

Enderle, 2023). The ability of teachers to use technology well is among the characteristics that a good teacher should have (DeCoito & Richardson, 2018; Koşar, et al., 2003; Ogelman, Demirci & Güngör, 2023), however, the fact that preschool teachers in this research expressed their self-perception of scientific literacy in terms of whether they can use technology well or not suggests that they may be mistaken in thinking that individuals who can use technology but have no interest in science can also exist in society. Similarly, when asked about the benefits of scientific literacy in preschool education, preschool teachers' responses indicating that it would enable the integration of technology into the educational process suggest that even a preschool teacher who uses technology in their scientific activities may not use it enough by saying that they already use technology in the educational process. However, the preschool period is a critical period for the implementation of scientific activities (Tu, 2006). At this point, it will be important to further investigate the concept confusion regarding scientific literacy and technology literacy, to collect and analyze data on how often and how preschool teachers use technology in scientific activities through questions that will be addressed in study groups where female and male preschool teachers are equally represented, and to explore whether there is a difference in scientific literacy and technology literacy between them. The data collection tools used in this study were selected for their reliability and validity. However, it should be noted that the measurement tool may not fully reflect the most recent developments in the field of scientific literacy, which is acknowledged as a limitation of this research.

Based on the result that the scientific literacy levels of preschool teachers increase with educational practices (scientific journal subscription/follow-up, participation in projects), the scientific literacy levels of preschool teachers become important, especially in the preschool period, when scientific concept knowledge and scientific process skills begin to develop. At this point, increasing science-themed projects and practices in preschool teacher education, adding science-themed content to in-service trainings, initiating free science-themed journal subscriptions for kindergartens and preschools by the Ministry of National Education in Turkey, and distributing picture books that provide information on science themes can provide support for both preschool teachers and preschool children to become scientifically literate individuals.

Declarations

Ethics statements

In this study, ethical principles were observed by protecting the confidentiality of the participants. Before starting the data collection process, the necessary ethics committee application for the research was made, and after receiving ethics committee approval from the Trakya University Social and Human Sciences Ethics Committee, the measurement tools were transferred to the online platform and distributed throughout Türkiye.

Informed consent

Informed consent was obtained from all participants through an online form. Before completing the form, participants were informed about the purpose and procedures of the study, and their consent was obtained electronically.

Availability of data and materials

Availability of data and materials: The data and materials used in the study can be shared with relevant researchers. However, the data will be provided within certain limitations in accordance with participant confidentiality and data security principles.

Competing interests

The authors declare that they have no conflicts of interest

Funding

Authors' contributions

The design of the study, data collection, and analysis processes were carried out by Dr. Gülşah Günşen; Dr. Tuğba Kontaş Azaklı and Prof. Dr. Gülden Uyanık contributed to the interpretation of the findings and took responsibility for writing the manuscript. All authors reviewed and approved the final version of the study.

Acknowledgments

References

Autieri, S. M., Amirshokoohi, A., & Kazempour, M. (2016). The Science-Technology-Society Framework for Achieving Scientific Literacy: An Overview of the Existing Literature. *European Journal of Science and Mathematics Education*, 4(1), 75-89.

Akcanca, N., Gürler, S. A., & Alkan, H. (2017). Determination of Preschool Teachers' Opinions on Science Education Practices. *Caucasian Journal of Science*, 4(1), 1-19.

Altunışık, R. (2015). Big Data: Source of Opportunities or Cluster of New Problems? *Yildiz Social Science Review*, 1(1), 45-76.

Aymak, Ö. (2023). Examination of Class Teachers' Scientific Literacy Levels and Attitudes towards History of Science. *[Unpublished Doctoral Dissertation]*. Dokuz Eylül University.

Bacanak, A. (2002). A study on the evaluation of prospective science teachers' science literacy and the implementation of science-technology-society course. *[Unpublished Master's Thesis]*. Karadeniz Technical University.

Barenthien, J., Lindner, M. A., & Ziegler, T. (2018). Exploring Preschool Teachers' Science-Specific Knowledge. *Early Years*, 1–16. https://doi.org/10.1080/09575146.2018.1443321

Bartan, M. (2020). Examination of Preschool Teacher Candidates' Basic Scientific Literacy Levels and Scientific Attitudes. *Pamukkale University Journal of Education*, 49, 293-308.

Bassiouni, D., & Hackley, C. (2014). Generation Z Children's Adaptation to Digital Consumer Culture: A Critical Literature Review. *Journal Of Customer Behaviour*, 13(2), 113-133.

Bronfenbrenner, U., & Morris, P. (2006). The Bioecological Model of Human Development. In R. M. Lerner & W. Damon (Eds.), *Handbook of Child Psychology: Vol. 1. Theoretical Models of Human Development* (6th ed., pp. 793–828). Hoboken, NJ: Wiley

Büyüköztürk, Ş. (2014). *Data Analysis Handbook for Social Sciences: Statistics, Research Design, SPSS Applications, and Interpretation*. (19th Edition). Ankara: Pegem Academy.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2020). *Research Methods in Science* (28th Edition). Pegem Publishing.

Bybee, R. W., & Fuchs, B. (2006). Preparing the 21st Century Workforce: A New Reform in Science and Technology Education [Editorial]. *Journal of Research in Science Teaching*, 43(4), 349–352. https://doi.org/10.1002/tea.20147

Cadime, I. (2024). Teachers' beliefs and practices to support emergent literacy development in preschool education: the moderating role of continuous training. *International Journal of Early Childhood*. https://doi.org/10.1007/s13158-024-00393-2

Chatila, H. (2016). Use of biographical recount of famous scientists to enhance scientific literacy for new pre-service primary science teachers at the Lebanese university. *Journal of Education in Science Environment and Health*, 2(2), 134-144.

Cohen, J. (1960). A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*, 20(1), 37-46.

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods Research*. Sage. Christensen, L. B., Johnson, R. B., & Turner, L. A. (2015). *Research Methods*. (A. Aypay, Trans.). Anı.

Creswell, J. W., & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory in to Practice*, 39(3), 124–130.

Creswell, J. W., & Plano Clark, V. L. (2015). *Mixed Methods Research: Design and Conduct*. (Y. Dede & S. B. Demir, Trans.), Ankara: Anı

Čipková, E., Karolčík, Š., Dudová, N., & Nagyová, S. (2018). What is the students' interest in biology after the biology curriculum modification? *The Curriculum Journal*, 29(3), 370-386.

Dağlı, H., & Dağlıoğlu, H. E. (2020). Examination of Preschool Teachers' Views on the Content and Standards of Science Education. *OPUS International Journal of Society Research*, 15(23), 1-1.

DeCoito, I., & Richardson, T. (2018). Teachers and Technology: Present Practice and Future Directions. *Contemporary Issues in Technology and Teacher Education*, 18(2), 362-378.

Demirbaş, M., & Yağbasan, R. (2006). The Functional Importance of Scientific Attitudes in Science Education and Adaptation of Scientific Attitude Scale to Turkish. *Uludağ University Journal of Education Faculty*, 19(2), 271-299.

Dombaycı, M. A., & Ercan, O. (2017). Examination of Prospective Teachers' Scientific Literacy Levels and Attitudes towards Scientific Research in Terms of Various Variables. *Abant İzzet Baysal University, Journal of Education Faculty*, 17(3), 1265-1284

Duban, N. (2010). Prospective Classroom Teachers' Views on Science and Technology Literate Individuals and Their Education. *Theoretical Education Science Journal*, 3(2), 162−174.

Erbudak, K. C. (2021). Scientific Literacy Levels of Social Studies Teacher Candidates. *[Unpublished Doctoral Dissertation]*. Gazi University, Institute of Education Sciences, Ankara.

Garbett, D. (2003). Science Education in Early Childhood Teacher Education: Putting Forward a Case to Enhance Student Teachers' Confidence and Competence. *Research in Science Education*, 33(4), 467-481.

Gezgin, D., & Kılıç, D. (2015). Determination of Gain and Methods Preferred by Preschool Teachers in Science Activities. *Mersin University Journal of Education Faculty*, 11(3), 620-630.

Glesne, C. (2012). *Introduction to Qualitative Research*. A. Ersoy & P. Yalçınoğlu (Trans.). Anı Publishing.

Göktepe, D. (2019). Evaluation of science teachers' scientific literacy skill levels in terms of various variables: sakarya province example. *[Unpublished Master's Thesis]*. Abant İzzet Baysal University.

Gropen, J., Kook, J. F., Hoisington, C., & Clark-Chiarelli, N. (2017). Foundations of Science Literacy: Efficacy of a Preschool Professional Development Program in Science on Classroom Instruction, Teachers' Pedagogical Content Knowledge, and Children's Observations and Predictions. *Early Education and Development*, 28(5), 607−631.

Hurd PD (1958) Science literacy: its meaning for American schools. *Educ Leadersh*, 16(1):13−16. https://edcipr.com/wp-content/uploads/2016/09/Hurd_1958_Science-literacy.pdf

Huyugüzel Çavaş, P. H. (2009). Determination of Primary School Teachers' Science and Technology Literacy and Teaching Competencies. *[Unpublished Doctoral Dissertation]*. Dokuz Eylül University.

Işık-Terzi, C. (2008). Examination of primary school teachers teaching science and technology in the first and second stages and comparison of their science literacy levels. *[Unpublished Master's Thesis]*. Muğla Sıtkı Koçman University

Kallery, M., & Psillos, D. (2001). Preschool Teachers' Content Knowledge in Science: Their Understandings of Elementary Science Concepts and Issues Raised by Children's Questions. *International Journal of Early Years Education*, 9(3), 165−177.

Karademir-Alkan, Ç. (2012). Prospective Classroom Teachers' Opinions on Science and Technology Literacy. *Bartın University Journal of Education Faculty*, 1(1), 236-251.

Kızılay, E., & Kırmızıgül, A. S. (2020). Examination of Classroom Teacher Candidates' Views on Science Literacy. *International Karamanoğlu Mehmetbey Education Research Journal*, 2(1), 71-78.

Koşar, E., et al. (2003). *Educational Technologies and Material Development*, Ankara: PEGEM A., p.1.

Kuckartz, U. (2014). *Mixed Methods: Methodologies, Research Designs and Analysis Methods*. Springer-Verlag.

Kurniah, N. (2023). Integration of scientific literacy and technology in designing early childhood learning. *Indonesian Journal of Early Childhood Education Studies*, 12(2), 204-210. https://doi.org/10.15294/ijeces.v12i2.75634

Laugksch, R. C. (2000). Scientific Literacy: A Conceptual Overview. *Science Education*, 84(1), 71−94.

Laugksch, R. C., & Spargo, P. E. (1996). Development of a Pool of Scientific Literacy Test-Items Based on Selected AAAS Literacy Goals. *Science Education*, 80(2), 121-143.

Lee, O. (2001). Culture and Language in Science Education: What Do We Know and What Do We Need to Know?. *Journal of Research in Science Teaching*, 38(5), 499-501.

Lind, K. K. (1999). Science in Early Childhood: Developing and Acquiring Fundamental Concepts and Skills. In: *Dialogue on Early Childhood Science, Mathematics, and Technology Education*. Washington, DC: American Association for the Advancement of Science

McCray, J. S., & Chen, J.-Q. (2012). Pedagogical Content Knowledge for Preschool Mathematics: Construct Validity of a New Teacher Interview. *Journal of Research in Childhood Education*, 26, 291−307.

McHugh, M. L. (2012). Interrater Reliability: The Kappa Statistic. *Biochemia Medica*, 22(3), 276-282.

Ministry of National Education [MEB], 2023. *Updated Preschool Education Curriculum*. https://tegm.meb.gov.tr/dosya/okuloncesi/guncellenenokuloncesiegitimprogrami.pdf

Ministry of National Education [MEB], 2024. *Turkey Century Maarif Model Preschool Education Curriculum*. https://tymm.meb.gov.tr/upload/program/2024programokuloncesiOnayli.pdf

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. Sage.

Miles, M. B., Huberman, A. M., & Saldana, J. (2013). *Qualitative Data Analysis: A Methods Sourcebook*. Thousand Oaks, CA: SAGE Publications.

Miller, J. D. (1983). Scientific Literacy: A Conceptual and Empirical Review. *Daedalus*, *112*(2), 29−48.

Ogelman, H. G., Demirci, F., & Güngör, H. (2023). Examination of Preschool Teacher Candidates' Digital Literacy Self-Efficacy and Attitudes towards Technology. *Ağrı İbrahim Çeçen University Journal of Social Sciences Institute*, *9*(2), 195-224.

Orhan, A. T. (2019). Examination of Preschool Teachers' Perspectives on Science Centers and Science Education in Their Schools. *Gazi Journal of Educational Sciences*, *5*(1), 91-101.

Osborne, J. (2023). Science, Scientific Literacy, and Science Education. In *Handbook of Research on Science Education* (pp. 785-816). Routledge.

Önder, F., Sılay, İ., & Şenyiğit Ç. (2017, November). Factors Affecting Teacher Candidates' Scientific Literacy Skills: Academic Achievement and Field. *3rd International Education, Distance Education and Educational Technologies Congress*, Antalya.

Özdemir, A. (2011). Examination of science and technology literacy levels and attitudes towards science of classroom teachers. *[Unpublished Master's Thesis]*. Middle East Technical University.

Öztaş, F. (2019). Examination of classroom teacher candidates' scientific literacy levels and their views on the nature of science. *[Unpublished Master's Thesis]*. Kahramanmaraş Sütçü İmam University.

Patton, M. Q. (2014). *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. Sage publications.

Pereira, S., Rodrigues, M. J., & Vieira, R. M. (2020). Scientific Literacy in the Early Years – Practical Work as a Teaching and Learning Strategy. *Early Child Development and Care*, *190*(1), 64-78.

Saçkes, M., Trundle, K. C., & Bell, R. L. (2013). Science Learning Experiences in Kindergarten and Children's Growth in Science Performance in Elementary Grades. *Education and Science*, *38*(167), 114−127.

Schwartz, R. S., Lederman, J. S., & Enderle, P. J. (2023). Scientific Inquiry Literacy: The Missing Link on the Continuum from Science Literacy to Scientific Literacy. In *Handbook of Research on Science Education* (pp. 749-782). Routledge.

Siraj-Blatchford, I., Sylva, K., Muttock, S., Gilden, R., & Bell, D. (2002). *Researching Effective Pedagogy in the Early Years*. London: Department for Education and Skills

Sepúlveda-Vallejos, S., Almonacid-Fierro, A., Grisales, N., & Valdebenito, K. (2023). Sources of information that guide the pedagogical work of early childhood educators: an exploratory study in chile. *Journal of Curriculum and Teaching*, *12*(1), 162. https://doi.org/10.5430/jct.v12n1p162

Stemler, S. E. (2004). A Comparison of Consensus, Consistency, and Measurement Approaches to Estimating Interrater Reliability. *Practical Assessment, Research, and Evaluation*, *9*(1), 4.

Sultan, A. A., Henson Jr. H., & Fadde, P. J. (2018). Pre-Service Elementary Teachers' Scientific Literacy and Self-Efficacy in Teaching Science. *IAFOR Journal of Education*, *6*(1), Spring 2018.

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research*. Sage Publications.

Sylva, K., Sammons, P., Chan, L. L. S., Melhuish, E., Siraj-Blatchford, I., & Taggart, B. (2013). The Effects of Early Experiences at Home and Pre-School on Gains in English and Mathematics in Primary School: A Multilevel Study in England. *Zeitschrift Fur Erziehungswissenschaft*, *16*(2), 277−301. https://doi.org/10.1007/

Tatlı, E. (2017). The effect of science fiction activities on the scientific knowledge comprehension, scientific literacy, and attitudes towards science of science teacher candidates *[Unpublished master's thesis]*. Marmara University.

Tekin, N. (2013). Investigation of the relationship between scientific literacy and critical thinking skills of science teacher candidates *[Unpublished master's thesis]*. Necmettin Erbakan University.

Tekin, N., Aslan, O., & Yağız, D. (2016). Examination of science teacher candidates' scientific literacy levels and critical thinking tendencies. *Amasya University Journal of Education Faculty*, *5*(1), 23-50.

Toraman-Turk, S. (2023). *Qualitative research and action research in social sciences: approaches, new quests, and applications*. Pegem Academy.

Trundle, K., & Saçkes, M. (Eds.). (2015). *Research in early childhood science education*. Dordrecht, The Netherlands: Springer.

Tu, T. (2006). Preschool science environment: What is available in a preschool classroom?. *Early Childhood Education Journal*, *33*, 245-251.

Tunç Şahin, C. (2013). Improving the scientific literacy of social studies teacher candidates: designing the "science, technology, and social change" course through action research. *[Unpublished doctoral dissertation]*. Marmara University.

Turgut, H., (2005). The effect of constructivist design application on the development of science teacher candidates' scientific literacy competencies in the dimensions of "nature of science" and "science-technology-society relationship" *[Unpublished doctoral dissertation]*. Yıldız Technical University.

Turgut, H., & Fer, S. (2006). The Effect of Social Constructivist Instructional Design to Prospective Science Teachers' Scientific Literacy Proficiencies. *Marmara University Ataturk Faculty of Education Journal of Educational Sciences*, 24, 205-229.

Ulutaş, Ö. (2009). Investigating the scientific literacy levels and attitudes towards science of science teacher candidates *[Unpublished master's thesis]*. Middle East Technical University.

Ünal, M., & Akman, B., (2006). Attitudes of preschool teachers towards science education. *Hacettepe University Journal of Education Faculty*, 30, 251-257.

Yavuz, E. (2018). Examination of the scientific literacy of primary and middle school teachers. *Erciyes Journal of Education*, 2(1), 1-18.

Yetişir, M. Ġ. 2007. The levels of science and technology literacy of the teacher candidates studying in the first grade of elementary science teaching and classroom teaching *[Unpublished master's thesis]*. Gazi University.

Yıldırım, A. & Şimşek, H. (2013). *Qualitative research methods in the social sciences*. (9th Edition). Ankara: Seçkin Publication.

Yolagiden, C. (2017). Investigation of the relationship between science learning skills, science literacy, and attitudes towards socio-scientific issues of teacher candidates *[Unpublished master's thesis]*. Kahramanmaraş Sütçü İmam University.

Zhao, Z. (2024). Research on the path of high-quality development of preschool teachers. *Lecture Notes in Education Psychology and Public Media*, 40(1), 236-240. https://doi.org/10.54254/2753-7048/40/20240763