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Investigation of Preservice Science Teachers' Scientific Literacy Skills in terms of Academic Achievement, University Entrance Exam Scores and Grade Level

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The first aim of this research is to investigate preservice science teachers' scientific literacy skills in terms of university entrance exam scores, academic achievement average scores, grade levels and academic achievement levels. And the second one is to determine the predictive power of university entrance exam scores and academic achievement average scores on scientific literacy skills. In line with these listed aims of the research, this study was carried out in survey design of the quantitative paradigm. 154 preservice science teachers constituted the participants of this research. The participants' skills scores were obtained with "Scientific Literacy Skills Test" and the research hypotheses were tested statistically. Results revealed that participants' scientific literacy skills differed in favor of upper classes, there was significant but low relationship between their skills and academic achievement average scores. In addition, it was found that participants' university entrance exam scores did not significantly predict their skills, academic achievement average scores significantly predicted their skills but at a low rate (7%) and there was no significant relationship between their university entrance exam scores and skills. In line with these results, suggestions were made regarding the revision of universities' science teaching programs with the object to advance preservice science teachers' scientific literacy skills.

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Introduction

In today's world, individuals are expected to have idea about many concepts, processes related to science and technology and to make this knowledge a part of their daily life for democratic participation in society. To contribute to economic productivity and welfare, it is necessary to make healthy individual decisions on scientific, technological controversial issues and to create a public opinion that will guide authorized decision makers (National Research Council [NRC], 1996; Turgut, 2021). For this, firstly scientific concepts and processes should be understood and therefore scientific literacy skills should be developed and disseminated. This perspective shapes current science education programs and educators focus on individuals' scientific literacy skills (Maranan, 2017), and included them as a direct and vital competence in the context of the scientific and technological movement of our age, especially in the curricula of developed countries (Millar, 2006).

With a similar approach, the goal of raising all individuals as scientifically literate is mentioned in the science education program of Turkey, and it is aimed to develop competence in sub-dimensions such as content knowledge, scientific research and process skills, the process of scientific knowledge production, decision-making and reasoning skills in socioscientific issues (Ministry of National Education, 2018). Such a goal indicates the necessity of going beyond the processes in which scientific concepts are memorized and focusing on creating deep understanding, developing high-level thinking skills, associating scientific concepts with real living conditions and scientific literacy skills are seen to be crucial in this sense (Özcan & Turgut, 2014; Kim & Kim, 2021; Organization for Economic Cooperation and Development [OECD], 2013). For understanding and justifying this importance attributed to scientific literacy, firstly a conceptual analysis must be made, but while doing this, the differentiation in the historical development process must also be considered. It is known that the effects arising from the changes in the relevant political, philosophical, and basic educational perspectives lead to periodic differences in the sense attributed to scientific literacy (Laugksch, 2000; DeBoer, 2000).

Scientific Literacy

The current conceptual context of scientific literacy began to take shape in the post-second world war period, when the effects of the applications of science and technology on the social, economic, political life and welfare level of societies were clearly seen (Hurd, 1998). Since then, there have been changes in the meaning attributed to it, but today's understanding of scientific literacy can be considered around nature of science, scientific content, relationship between science-technology-society and a series of skills and competencies accompanying these fields (Turgut, 2007). Such an acceptance requires focusing on the understanding of science as a way of knowing and understanding the processes leading to scientific knowledge.

The process leading to scientific knowledge has a versatile and dynamic nature and beyond being a mere collection of content knowledge, scientific enterprise that requires interactive, collaborative processes and skills (Karamustafaoğlu, 2007; Roth & Barton, 2004) is a kind of cultural activity that gains reality in the scientific community (Kirch, 2007). Therefore, in any scientific sub-discipline, a cultural adaptation is required in order to gain competence by understanding the working, reasoning, problem solving and knowledge production processes of scientists (Nunes, 1999). The scientific literacy perspective of the Program for International Student Assessment (PISA) dealing with the capability to identify problems connected scientific topics, acquire new information, explain facts, and participate in discussions on scientific topics, thus reaching evidence-based conclusions (OECD, 2014) points to the importance of this cultural adaptation. Similarly, in the report titled "Scientific Literacy: Concepts, Contexts and Consequences" prepared by the National Academies of Science, Engineering and Medicine (2016), it is seen that scientific literacy is considered in the form of being familiar with scientific enterprise, processes and applications. The competence of using data and evidence in evaluation process of scientific knowledge claims and especially the arguments put forward by scientists in various media which thought as an important part of scientific literacy by the National Research Council (NRC, 1996) can also be considered within this scope.

The issues highlighted in these expansions indicate that scientific literacy can be handled with a focus on individuals' ability to comprehend scientific issues and ideas as inquiring and reflective citizens (OECD, 2016; Bybee, 2016). Such a set of understanding and skills has turned into a more vital and strategic competence, especially with the global problems encountered after the Covid-19 epidemic, and it has been understood more how important the scientific knowledge and thought system is at the point of democratic participation in the relevant decision-making processes (Valladeres, 2021). Discussions on vaccination and community immunity can be counted among the current topics in this context. Therefore, the claim that individuals should have scientific content knowledge, mental abilities, characters and values required for responsible behavior, understanding about scientific enterprise with its epistemology and relationship with society, meta-cognition and self-management skills (Choi, Lee, Shin, Kim, & Krajcik, 2011) can be put on the agenda more strongly.

It is clear that today's individuals are expected to be able to understand at least a certain level of the reasoning of scientists, the scientific culture and thus to be vigilant against false information claims and conspiracy theories that have place in social life but contradict established scientific findings (DeBoer, 2000; Howell & Brossard, 2021). They need to be able to evaluate the claims and evidence they access through media channels, interpret numerical data by making sense of it and use scientific knowledge in various real-life situations (Ryder, 2001). So, competencies such as critical thinking, questioning the validity of information claims, using scientific knowledge and cognitive skills in problem solving processes, forming reasoned individual judgments to participate in democratic processes by understanding the social context of science and technology come to the fore. (Turgut, 2021).

With these skills, individuals will be able to find the healthy way for them in dynamic scientific issues and gain ability in accessing and critically applying reliable scientific information needed in informed decision-making duration concerning both individual and social points (Dillon, 2009; Howell & Brossard, 2021). Such a competency can be developed in the context of an individual's experiences in and out of school environments as a part of his/her lifelong learning process (Liu, 2009) and science education comes to the forefront in terms of both content and skills, especially in-school learning. Presenting scientific literacy as a direct target in recent science education reform initiatives (NRC, 1996) and pointing out the skills that individuals will need to use scientific knowledge in real-life situations (American Association for the Advancement of Science [AAAS], 1990; DeBoer, 2000) can also be interpreted in this sense. With this understanding, this research focused on the scientific literacy skills of preservice science teachers in the light of related literature and discussions presented above and by making an evaluation in terms of different variables the following research hypotheses were developed.

Research Hypothesis

Research regarding scientific literacy are seen to be mostly focused on the developmental status of countries (Bybee, 2008; Shen, 1975) and conducted with primary, secondary and tertiary school students (Arduç & Kahraman, 2021) on the basis of variables such as gender (Altun-Yalçın, Açışlı, & Turgut, 2011; Keskin, Tezel, & Acat, 2016; Mukti, Yuliskurniawati, Noviyanti, Mahanal, & Zubaidah, 2019), school type (Özbay, 2011) and socioeconomic status (Baz, 2003). However, the variables of university entrance exam scores (raw scores based on exam performance; total scores calculated with addition of raw and secondary school success scores) as the indicator of scientific literacy skills development at the secondary level and academic achievement average scores as the sign of competencies acquired at the tertiary level are not questioned adequately. Therefore, to test the relationship of participants of this research's participants scientific literacy skills with their university entrance exam scores and undergraduate academic achievement average scores, following H_1 and H_2 hypotheses were created:

H_1: Preservice science teachers' scientific literacy skills and university entrance exam scores are meaningfully related.

H_2: Preservice science teachers' scientific literacy skills and undergraduate academic achievement average scores are meaningfully related.

Scientific literacy is thought as skills oriented (Turgut, 2021), and one of the important contexts in which varying experiences provided for the acquirement and development of these skills is school (Liu, 2009). For this reason, to test differentiation of preservice science teachers' scientific literacy skills according to their grade levels, following H_3 hypothesis was created:

H_3: Preservice science teachers' scientific literacy skills are meaningfully effected by their grade levels.

It was concluded that there is significant relationship between participants' scientific literacy skills and academic achievement levels (Tekin, Aslan & Yağız, 2016). Therefore, to test the effect of preservice science teachers' academic achievement levels on their scientific literacy skills, following H_4 hypothesis was created:

H_4: Preservice science teachers' scientific literacy skills are meaningfully effected by their academic achievement levels.

In addition, considering all these variables, in order to determine the predictive power of participants' university entrance exam scores and undergraduate academic achievement average scores for their scientific literacy skills, following H_5 and H_6 hypotheses were created:

H_5: Preservice science teachers' university entrance exam scores predict their scientific literacy skills.

H_6: Preservice science teachers' academic achievement average scores predict their scientific literacy skills.

Research Method

Research Design

This research, based on quantitative paradigm, was conducted with survey design (Punch, 2003). The examination of preservice science teachers' scientific literacy skills in terms of their grade and academic achievement levels was performed according to the cross-sectional survey design (Fraenkel, Wallen & Hyun, 2014). The relationship of preservice science teachers' scientific literacy skills with their university entrance exam scores and undergraduate academic achievement average scores was questioned according to relational survey design (Fraenkel, Wallen & Hyun, 2014; Özmen & Karamustafaoğlu, 2019).

Participants

In survey studies, the sample of participants are expected to be able to represent the universe. In addition, it is also necessary to meet the accessibility, voluntariness, and control of process criteria in order to obtain and interpret data in a healthy manner. In this study, considering these issues together, priority was given to the university where the researchers work, and an evaluation was made on the university entrance exam scores of the students enrolled in this university's undergraduate science teaching program. For this purpose, the data of the Higher Education Program Atlas were examined, and it was determined that the undergraduate science teaching program of the researchers' university was ranked 29th out of 66 universities in 2019, 29th out of 65 universities in 2020, 30th among 65 universities in 2021, and 28th out of 69 universities in 2022. This data was interpreted as that the students enrolled in the selected science teaching undergraduate program entered the university with a success ranking close to the national average and did not represent any extreme group. So, considering that the candidate participants represented the average level in terms of academic achievement and the researchers had close information about the teaching processes, had opportunity to collect data in natural setting, it was decided that the study would be carried out at the researchers' university.

After this decision, all the students enrolled in the science teaching undergraduate program of the researchers' university were reached and informed about the subject, purpose and process of the research. The participation of volunteered ones among them was requested, and 155 of 172 preservice science teachers responded positively to this call. Then, the Scientific Literacy Skills Test was given to these 155 candidate participants and the data obtained were converted into z-scores to be examined in terms of extreme values in order to determine the actual participants to be taken as data source. In determining the extreme values, Mertler and Vannatta's (2005) range of +3.00 and -3.00 was taken into account and 1 preservice science teacher whose scientific literacy test z score was outside this range ($z_{scientificliteracy} > +3.00$) was excluded from the study group. Therefore, the research was carried out with 154 preservice science teachers.

The distribution of participants according to their grade and academic achievement levels is given in Table 1 below:

Table 1. Distribution of Participants by Grades and Academic Achievement Levels

Grade Level	f	%	Lower Group		Upper Group	
			f	%	f	%
1st	36	23,4	25	61,0	1	2,4
2nd	43	27,9	9	22,0	16	39,0
3rd	44	28,6	6	14,6	15	36,6
4th	31	20,1	1	2,4	9	22,0
Total	154	100	41	100	41	100

The data presented in Table 1 showed that a total of 154 preservice science teachers participated in the study and 23,4 % of them were 1st; 27,9 % of them were 2nd; 28,6 % of them were 3rd; 20,1 % of them were 4th grade. There were 41 pre-service science teachers with low achievement level and 61 % of them were 1st; 22 % of them were 2nd; 14,6 % of them were 3rd; 2,4 % of them were 4th grade. There were also 41 pre-service science teachers with high achievement level and 2,4 % of them were 1st; 39 % of them were 2nd; 36,6 % of them were 3rd; 22 % of them were 4th grade. The criteria of 27 % was taken into account (Gelman & Park, 2009; Hasançebi, Terzi & Küçük, 2020) in determining these lower and upper academic achievement groups that created for distinctiveness related to academic achievement. For this, the undergraduate academic achievement average scores of the participants were ranked from low to high, and the lowest 27 % was defined as the lower achievement group while the highest 27% was defined as the upper achievement group. In the analyses related to the academic achievement level, the data obtained from these upper and lower achievement groups, and in the analyses related to the other variables, the data obtained from the whole study group were taken as basis.

Data Sources

In this study, the “Scientific Literacy Skills Test” that developed by Gormally, Brickman, and Lutz (2012) and adapted into Turkish by Şahin-Kalyon (2020) was used to determine the scientific literacy skills of preservice science teachers. The Scientific Literacy Skills Test is a 25-item measurement tool which based on 9 sub-skills under the categories of “comprehending research methods for obtaining scientific knowledge” and “organizing, analysing and interpreting quantitative data and scientific information”. As a result of the analyses carried out in the Turkish adaption process of the test, it was concluded that it is a valid and reliable measurement tool that can be used unidimensional in determining the scientific literacy skills of Turkish university students (Şahin-Kalyon, 2020). In this research the internal consistency of the test was evaluated by calculation of the KR-20 coefficient (Tan, 2009), which was deemed appropriate for the data sets using the “0-1” scoring method and found to be 0,735. This result (.50<KR-20=.735<.80) showed that the test data obtained had an acceptable level of reliability (Salvucci, Walter, Conley, Fink, & Saba, 1997).

Data Analyses

In the data analysis process of the research, first of all, the general conditions for the use of parametric tests were checked. Yazıcı and Yolacan (2007) stated that if there are 20<n<50 participants in each subgroup, the skewness and kurtosis values can be measured with Shapiro Wilk. For this reason, to determine the normal distribution of the groups, central tendency measurements were examined with the help of the Shapiro Wilk test and the values obtained are presented in Table 2 below:

Table 2. Central Tendency Measurements

Scientific Literacy	Variable		Shapiro Wilk			Central Tendency Measurements	
			Statistics	**df**	**p**	**Skewness**	**Kurtosis**
	Academic Achievement Levels	Lower Group	,967	41	,283	,074	-,404
		Upper Group	,974	41	,448	-,046	,247
	Grade Level	1st Grade	,932	26	,086	-,419	,365
		2nd Grade	,945	25	,193	-,161	-,807
		3rd Grade	,902	21	,039	-,303	-1,277
		4th Grade	,947	10	,632	-,421	1,435
University Entrance Exam Scores (Raw)			,856	154	,000	1,393	2,265
University Entrance Exam Scores (Total)			,852	154	,000	-1,694	3,611
Academic Achievement Average Scores			,935	154	,000	-1,203	3,555

The data presented in Table 2 showed that the skewness values for academic achievement and grade levels of the participants ranged from -.421 to .074, and the kurtosis values ranged from -1.277 to 1.435. According to Tabachnick & Fidell (2013) skewness and kurtosis values should be between -1.5 and +1.5. Therefore, in this research it is revealed that the groups exhibited a normal distribution for the related variables. However, it was determined that the skewness values for variables of the participants' university entrance exam scores (raw and total) and academic achievement average scores had varied between -1.694 and 1.393. the kurtosis values ranged between 2.265 and 3.611, and it was determined that a normal distribution could not be achieved for these variables.

First of all, arithmetic mean, standard deviation and minimum-maximum score calculations were made to determine the descriptive statistical data regarding the scientific literacy skill scores of the participants. Then, Spearman correlation coefficient (r) was calculated to reveal the relationship between participants' scientific literacy skills and university entrance exam scores, academic achievement average scores (H_1 and H_2). In this calculation, the correlation coefficient is accepted to be low in the range of $0.01 \leq r \leq 0.29$; medium in the range of $0.30 \leq r \leq 0.70$ and high in the range of $0.71 \leq r \leq 0.99$ (Köklü, Büyüköztürk, & Çokluk Bökeoğlu, 2006). The effect of participants' grade levels on their scientific literacy skills was questioned by ANOVA and multiple comparison tests were conducted subsequently to determine the source of this possible effect (H_3). The effect of participants' academic achievement levels on their scientific literacy skills was examined through the independent groups t-test (H_4). Lastly, linear regression analysis (at a significance level of .05) was performed to determine the predictive power of participants' university entrance exam and academic achievement average scores for their scientific literacy skills (H_5 and H_6).

Findings

In the study, first, the average, minimum and maximum values of participants' scientific literacy skills scores according to their grade levels were calculated and presented in Table 3 below:

Table 3. Scientific Literacy Skills Scores

	Grade Level	f	$\overline{X}$	Std.	Min.	Max.
Scientific Literacy Skills Scores	1st	36	46,4444	8,40559	24,00	64,00
	2nd	43	47,8140	11,10825	28,00	72,00
	3rd	44	51,2727	11,22365	28,00	76,00
	4th	31	53,1613	11,41665	28,00	80,00

The data presented in Table 3 indicated that the participants' scientific literacy skills average scores varied between ($\overline{X}$)= 46.4444 and ($\overline{X}$)= 53.1613, maximum scores varied between 64.00 and 80.00 and minimum scores varied between 24.00 and 28.00.
In the first and second hypotheses of this study, it was predicted that there would be a significant relationship between participants' scientific literacy skills scores and university entrance exam scores, undergraduate academic achievement average scores. The results of the correlation analysis performed to test these hypotheses were presented in Table 4 below:

Table 4. The Relationship Between Scientific Literacy Skills Scores and University Entrance Exam Scores, Undergraduate Academic Achievement Average Scores

Variables	f	Scientific Literacy Skill Score	University Entrance Exam (Raw)	University Entrance Exam (Total)	Academic Achievement Average Scores
Scientific Literacy Skills Scores	154	1	-,065	-,068	,284**
University Entrance Exam Scores (Raw)		-,065	1	,357**	,061
University Entrance Exam Scores (Total)		-,068	,357**	1	,149
Academic Achievement Average Scores		,284**	,061	,149	1

**p=,000<,05

The Sperman correlation coefficients (due to the non-normal distribution) presented in Table 4 showed that there is a significantly positive but low-level relationship between participants' scientific literacy skills scores and academic achievement average scores ($p<.05$, $0.01 \leq r \leq 0.29$). In addition, according to data presented in Table 4, any significant relationships were not found between participants' scientific literacy skills scores and university entrance exam raw/total scores. ($p>.05$).

In the third hypothesis of the study, it was predicted that the participants' grade levels would significantly effect their scientific literacy skills scores. The ANOVA results performed to test this hypothesis were presented in Table 5 below:

Table 5. Comparison of Scientific Literacy Skills Scores According to Grade Level

Source of Variance	Sum of Squares	df	Mean Squares	F	p
Between Groups	1011,653	3	337,218	2,979	,033
Within-Group	16982,321	150	113,215		
Total	17993,974	153			

The data presented in Table 5 showed that participants' scientific literacy skills scores differed significantly according to their grade levels [F(3–150) = 2.979, p=<.05]. In order to question the differences for grade levels, a multiple comparison test was conducted and the data obtained were presented in Table 6 below:

Table 6. Multiple Comparison of Scientific Literacy Skills Scores According to Grade Level

0	**Grade Level (J)**	**Mean Difference (I-J)**	**Standart Error**	**p**
4th Grade	3rd Grade	1,88856	2,49503	,450
	2nd Grade	5,34734	2,50700	,035
	1st Grade	6,71685	2,60710	,011
3rd Grade	4th Grade	-1,88856	2,49503	,450
	2st Grade	3,45877	2,28167	,132
	1st Grade	4,82828	2,39122	,045
2nd Grade	4th Grade	-5,34734	2,50700	,035
	3rd Grade	-3,45877	2,28167	,132
	1st Grade	1,36951	2,40370	,570
1st Grade	4th Grade	-6,71685	2,60710	,011
	3rd Grade	-4,82828	2,39122	,045
	2nd Grade	-1,36951	2,40370	,570

The data presented in Table 6 showed that participants' scientific literacy skills scores differed significantly between 1st and 4th grades in favor of 4th grade; 2nd and 4th grades again in favor of 4th grade; 1st and 3rd grades in favor of 3rd grade (p<.05). Although there were differences between 1st and 2nd grade, 2nd and 3rd grade, 3rd and 4th grade in favor of upper grades, these differences were not statistically significant (p>.05). The biggest difference between participants' scientific literacy skills scores was between 1st and 4th grades (I-J=6,71685) in favor of the 4th grade, and the lowest difference was between the 1st and 2nd grades (I-J= 1,36951) in favor of 2nd grade.

In the fourth hypothesis of the study, it was predicted that the participants' academic achievement levels would significantly affect their scientific literacy skills scores. This hypothesis was created with the assumption that the participants' undergraduate academic achievement average scores did not differ much from each other during their undergraduate education since they entered the university with close entrance examination score rankings. The participants' academic achievement levels were also determined on the basis of their undergraduate academic achievement average scores but here the focus was upper (27%) and lower (27%) academic achievement groups in order to reveal the possible difference in a qualified way in the comparison to be made. The difference between the scientific literacy skills scores of the mentioned groups was examined with the t-test and the results were presented in Table 7 below:

Table 7. Comparison of Scientific Literacy Skills scores According to Academic Achievement Levels

Variable		f	$\bar{X}$	std	t	df	p
Academic Achievement Level	Upper	41	44,8780	10,33488	-3,274	80	,002
	Lower	41	52,5854	10,97492			

The t-test results presented in Table 7 showed that there is a significant difference between upper and lower group participants' scientific literacy skills scores in favor of the upper group (t80=-3.274; p<.05).

In the fifth and sixth hypotheses of the study, it was asserted that the participants' scientific literacy skills scores would be predicted by university entrance exam scores and undergraduate academic achievement average scores. Results of the regression analysis carried out to test these hypotheses were presented in Table 8 below:

Table 8. Variables Predicting Scientific Literacy Skills Scores

	Variables	B	Standard Error	β	t	p
Scientific Literacy Skills Scores	Constant	53,566	9,366		5,719	,000
	University Entrance Exam Scores (Raw)	-,014	,033	-,035	-,430	,668
	R=,035; R^2=,001; p=,668; F=,185					
	Constant	58,085	8,622		6,737	,000
	University Entrance Exam Scores (Total)	-,021	,021	-,080	-,994	,322
	R=,080; R^2=,006; p=,322; F=,988					
	Constant	30,155	5,747		5,248	,000
	Academic Achievement Average Scores	6,895	2,020	,267	3,414	,001
	R=,267; R^2=,071; p=,001; F=11,652					

The R^2 values presented in Table 8 showed that approximately 7 % of the variance in participants' scientific literacy skills scores ($R^2_{adjusted}$=.065) could be explained by their undergraduate academic achievement average scores. It was revealed that [$F(1,152)$= 11,652, p=,001<,05] undergraduate academic achievement average scores could significantly predict scientific literacy skills scores in a low and positive way. However, considering the R^2 ($R^2_{adjusted\text{-}Raw\ Score}$=-,005, $R^2_{adjusted\text{-}Total\ Score}$=,000), F($F_{Raw\ Score(1,152)}$=,185;$F_{Total\ Score(1,152)}$=,988) and p>,05 values, it was determined that university entrance exam raw and total scores could not predict scientific literacy skills scores significantly and a regression model could not be presented to explain the total variance.

Discussion and Conclusions

Scientific literacy is discussed with different perspectives in the related literature (Lehrer & Schauble, 2006), and independent of the adopted point of view, the social role of it and its contribution to society are seen to be indisputably important (Walag, Fajardo, Bacarrisas, & Guimary, 2022). The social role of scientific literacy is short-term and evaluated in relation to the basic scientific ideas acquired but its contribution to society is long-term and indicates the ability to adapt to the rapidly changing and developing world. Therefore, the development of scientific literacy skills requires a qualified education and can be possible in a long process. In other respect, a qualified education is directly related to the innovations brought to educational institutions which are also a requirement of social development (Namal & Karakök, 2011).

It is known that the revolutions made in the field of education affect the establishment and functioning of higher education institutions in our country as well as all over the world (Sargın, 2007). Historically, it is seen that education plays a central role in raising individuals who will take part in important public duties, and colleges and universities were established in line with this need (Çağatay, 1990). This argument rises a natural expectation for individuals to develop their scientific literacy skills in universities, which are defined as "…a teaching institution consisting of high-level education, training, scientific research and publishing units" by the Turkish Language Society (Turkish Language Association, 2023). On the other hand, not only universities but educational institutions' aim of developing scientific literacy at different levels and especially in the context of science education (Al Sultan, Henson & Fadde, 2018) directed focus on science teacher training programs. Therefore, in this study, pre-service science teachers' scientific literacy skills were examined in terms of a few variables and the predictive power of some of these variables for scientific literacy skills were tried to be revealed.

In this study, it was seen that there was no significant relationship between preservice science teachers' university entrance exam and scientific literacy skills scores. With the measurement tool used in the research, scientific literacy was measured in the categories of "comprehending research methods for obtaining scientific knowledge" and "organizing, analysing and interpreting quantitative data and scientific information". Considering these categories and "scientific knowledge", "investigative nature of science", "science that provides information" and "science-technology-society interaction" (Boujaoude, 2002) dimensions of scientific literacy, this result may be interpreted as inability of university entrance exam which employs multiple choice questions to predict above listed categories or dimensions of scientific literacy. In this sense, it can be argued that the performance in scientific knowledge-based questions in the university entrance exams cannot be thought as an indicator of scientific literacy skills. The view that scientifically literate individuals should have many competencies, and that those who have scientific knowledge but have not developed scientific skills and understanding cannot be considered as scientifically literate (Bağcı-Kılıç, Haymana & Bozyılmaz, 2008) supported this argument.

Another result of this study was about the relationship between preservice science teachers' academic achievement (as a measure of achievement at undergraduate level) and scientific literacy skills scores. Although it was found that upper and lower academic achievement groups differed significantly for their science literacy skills scores and the relationship between participants' academic achievement and scientific literacy skills scores was significantly positive, this relationship was seen to be at a low-level. This result showed that the performance of the participants in the courses they took during undergraduate education did not effect their scientific literacy skills at the desired level. Segarra, Hughes, Ackerman, Grider, Lyda, & Vigueira (2018) had similarly found that there was no significant increase in their participants' scientific literacy test scores that determined in different educational periods. In line with this, they stated that this issue should be taken into account in the studies of curriculum reform movements. Dombaycı and Ercan (2017) had also concluded that there was no significant difference in scientific literacy scores of preservice teachers studying in science education, classroom education and philosophy education programs. Considering the aims of science teaching and teacher competencies, it can be said that the result of this research should be examined separately in depth, and science teaching undergraduate programs should be discussed in terms of content, process, measurement, and evaluation understandings. In this sense, Turgut and Fer's (2006) research can be reviewed, which revealed that the scientific literacy of pre-service science teachers can be improved effectively with social constructivist instructional design practices.

When scientific literacy skills scores of the preservice science teachers were examined at the grade levels, it was understood that they had low proficiency in the first grade. The findings of other studies carried out with different study groups seemed to be consistent with this result and showed that individuals' scientific literacy skills are not proficient (for example, Adnan, Mulbar, Sugiarti & Bahri, 2021; Firdaus, Ibrohim, Lestari, Masiah, Primawati, & Hunaepi, 2023; Özdemir, 2010; Süren, 2008). In the evaluations made on the basis of all grades, it was observed that the average scores increased with the grade level, and there was a significant difference between 1st and 3rd, 4th grades, and between 2nd and 4th grades. However, it was seen that the rates of these increases observed on the basis of average skills scores are not high. This result was also compatible with studies included evaluations of scientific literacy scores of students at different grades and presented significant but low increases in favour of upper grades (Turgut, 2018).

In this study, it was also found that participants' university entrance exam scores do not predict their scientific literacy skills scores. However, undergraduate academic achievement average scores can significantly predict their scientific literacy skills scores just at a low rate (7%). These results with the ones discussed above indicated that a series of scientific literacy skills-oriented arrangements should be made in the undergraduate science teaching programs. In this context, the real needs, life experiences and abilities of pre-service teachers should be taken into account, and ways to fully benefit from in-school and out-of-school resources should be sought (Harefa & Huang, 2023). While doing this, it should not be ignored that developing individuals' scientific literacy skills is a process that requires a long time and a system (Bağcı Kılıç, Haymana & Bozyılmaz, 2008).

Suggestions

Similar studies can be conducted in universities with different entrance exam score rankings, and the results obtained can be examined comparatively. A field-specific test that measures academic achievement for all grade levels can be developed and the predictive level of scientific literacy skills of these test results can be compared. Research can be conducted to structure the university entrance exam questions in a way that can measure scientific literacy skills. The contents and processes of science teaching undergraduate programs can be reviewed in the context of scientific literacy skills. In-depth qualitative research can be planned in order to reveal the reasons for the results obtained in this research.

Limitations

This study was conducted with preservice science teachers studying at a state university and their scientific literacy skills were measured with the "Scientific Literacy Skills Test". The results obtained may differ in studies to be conducted in universities with different student profiles and in which different measurement tools to be used.

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