

A Project Implementation on Improving Elementary Teachers' Water Comprehension, Water Literacy Levels, and Attitudes Towards Water

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Abstract

Education is one of the most effective tools for raising individuals' awareness and fostering societal transformation toward sustainable water management and preservation. In this context, enhancing teachers' water literacy, who will shape future generations, is vital to building a sustainable future. This research aims to encourage elementary teachers to develop and implement classroom projects and activities that foster water literacy, including water comprehension, literacy levels, and attitudes towards water. In the first part of the research, 17 elementary teachers received training on water. In the second part, the teachers developed learning activities on water literacy and carried out these activities. To determine the effectiveness of the training, the Personal Information and the Reflective Opinion Forms were used, and additionally, the Water Comprehension Test (WCT), the Water Literacy Scale (WLS) and the Water Attitude Scale (WAS) were used. As a result, it was found that this project encouraged the teachers to effectively implement water-related practices, and that the practices carried out by the teachers regarding water contributed positively to the sustainability of water.

Keywords: sustainability, water literacy, water comprehension, attitude towards water, elementary teacher

Introduction

Sustainable development is one of the fundamental principles of modern societies. Consuming existing natural resources in a way that meets the needs of future generations and thereby ensuring the continuity of these resources is the most important condition of sustainability. The concept of sustainability was defined in the Brundtland Report as meeting present needs without compromising the ability of future generations to meet their own needs (Yeni, 2014). However, increasing population and resource consumption threaten ecosystem sustainability (Brelet-Rueff, 2000). Water plays a critical role in sustaining life and supporting development, and its conservation is an important indicator of sustainability (Sach, 2019). Rising living standards and industrialization increase water demand, while resources remain limited (World Health Organization, 2006). Therefore, sustainable water management has become essential and is directly related to the United Nations Sustainable Development Goals (SDGs) (Gou et al., 2021). Water is essential for life, food production, and economic development (Talib, 2005; Pepper et al., 2006; Bibi et al., 2016; Doğan et al., 2022) and can be transported, stored, and reused (Meriç, 2004). Although most of Earth's surface is covered by water, only a small portion is freshwater (Angelakis et al., 2021; İbrahim et al., 2022). Saltwater accounts for 97.5% of total water, while freshwater constitutes only 2.5% (The United Nations World Water Development Report, 2020). Most of this freshwater is locked in glaciers, leaving only a very small percentage accessible for human use (Shiklomanov & Rodda, 2003; Bharucha, 2004; Patel & Patel, 2021). Due to population growth, industrialization, and climate change, water demand is increasing, and water scarcity has become a major global concern, making sustainable water management necessary (United Nations, 2018).

In order to protect water resources and ensure sustainability, individuals need knowledge, awareness, and positive attitudes toward water (Sözcü & Türker, 2020; Kang, 2022). These competencies are defined as water literacy, which includes understanding water systems, conservation, and sustainable use (Middlestadt et al., 2001; Willis et al., 2011; McCarroll & Hamann, 2020; Maniam et al., 2021; TÜBİTAK, 2020). Global reports emphasize that improving water literacy is one of the key solutions to water problems (WWAP, 2009; WWF, 2020). Teachers play a critical role in developing this awareness because they serve as role models and educators for future generations (Çankaya, 2014; Hui-Shuang, 2018; Sözcü & Türker, 2020). Water education is considered one of the most effective ways to address water-related problems, and teachers' water literacy is essential for raising water-conscious individuals (Ergin et al., 2009; Sammel & McMartin, 2014; Arthurs, 2019; Mills & Tomas, 2024). This research was carried out as part of a project aimed at improving teachers' water literacy through training. It is expected that water-literate teachers will contribute to raising students who are conscious of water sustainability.

Most studies focus on students, and research involving teachers is limited (Zuckerman, 1998; Stavridou & Marinopoulos, 2001; Thompson & Logue, 2006; Odom & Barrow, 2007; Fisher et al., 2011; Aytar & Ursavaş, 2022). Therefore, this study aims to contribute to the literature by presenting a training model designed to improve teachers' water literacy. This study aims to fill the gap in the literature by presenting a practical training model designed to enhance teachers' water literacy levels. Also, considering that the participants consist of elementary teachers, the findings of this study are significant for the literature in this field. In this context, the research problem of the presented project is formulated as follows: "What

is the effect of water literacy training on elementary school teachers' water comprehension levels, water literacy and water attitudes?". Additionally, the following sub-problems are addressed in this research:

1. What is the effect of the water literacy training on the water comprehension levels of the teachers?
2. What is the effect of the water literacy training on teachers' water literacy?
3. What is the effect of the water literacy training on teachers' water attitudes?
4. What is the effect of the water literacy training on the relationships between teachers' water comprehension levels, water literacy and water attitudes?
5. How does the training given for water literacy affect teachers' views?

Methodology

Research Model

This research was carried out using a one-group pretest-posttest experimental design. Experimental designs are research designs cause-effect relationship between variables (Fraenkel & Wallen, 1996; Cohen & Manion, 1997; Gay & Airasian, 2000). In experimental studies, researchers observe the effects of at least one independent variable on one or more dependent variable on one or more dependent variables (Campbell & Stanley, 1963; Balci, 2001; Karasar, 2002). There are many different experimental designs, one of which is the one-group pretest-posttest design used in this study, where the independent variable is applied to one group, and measurements are taken before and after the experiment (Fraenkel & Wallen, 1996; Cohen & Manion, 1997; Gay & Airasian, 2000). The difference between the pretest and posttest means indicates the effect of the independent variable on the dependent variable.

Research Group

The research group consists of 17 elementary teachers who are working in primary schools affiliated with the District Directorate of National Education in a district in Istanbul province in Türkiye. The research was conducted online due to the COVID-19 pandemic, and a limited sample was selected based on voluntary participation. However, this limitation was offset by the in-depth analysis methods used in the study. The applications of teachers were collected online based on specific criteria. These criteria include being an elementary teacher, voluntary participation, having an interest in water-related topics, and teaching experience. The demographic characteristics of the teachers, whose personal information was coded as "T1, T2, T3, ..." to ensure confidentiality, are presented in Table 1.

Table 1
Demographic Characteristics of Participating Teachers

Demographic Characteristics		N
Field of Teaching	Elementary Teacher	17
Professional Experience (year)	0-10	3
	11-20	8
	21 and over	7
Participation in Water Awareness Training	Participate	3
	Not participate	14
Membership in an Environmental Non-governmental Organization	Member	4
	Not a member	13
	Not knowledgeable	0

Implementation Process of the Research

As part of the presented project, teachers were provided with training to guide them in implementing water-related knowledge, water literacy, and positive attitudes in their own classrooms. Due to the pandemic conditions, this training was conducted through distance learning. The research was conducted via the Zoom Cloud Meetings program due to COVID-19. In the week before the training, an introductory meeting was held with the teachers, and the pretest application of data collection tools was conducted. Apart from the pretest and posttest applications, the training lasted for a total of 8 weeks-16 class hours (1 class hour=40 minutes), with 2 class hours per week. The training consisted of two parts. Firstly, teachers were given education on the subject of water, and in the second part, the activities carried out by the teachers related to the water topic were evaluated. In the final week of the training, a closing meeting was held with the teachers, and the posttest application of data collection tools was conducted. The water literacy training program applied to the teachers is presented in Table 2.

Table 2

Teacher Training Program on Water Literacy

Week	Educational Content
1	Water Chemistry and Properties, Water Standards, Water Cycle, Importance of Water, Water and Health
2	Global Water Status and Distribution of Water Resources, Quantity of Water Resources in Our Country, Sectoral Water Resource Utilization Worldwide and in Our Country
3	Water Losses in the World and in Our Country, Usable Water Amount per Capita in the World and in our Country, Water Savings, Increasing Water Problems in the World and in Our Country
4	Water Pollution and Wastewater Recovery, Water Footprint, Water Legislation
5	Analysis of Water-related Topics in Curricula across Various Disciplines, Examples of Water Teaching Implementations (Projects/Activities)
6	Teachers' designing and sharing projects/activities for student learning about water
7	Teachers' designing and sharing projects/activities for student learning about water
8	Teachers' designing and sharing projects/activities for student learning about water

During the initial phase of the training, theoretical knowledge was covered based on the topics outlined in Table 2, and practical examples related to these subjects were provided. In the following phase, each teacher developed a project or activity aimed at teaching the topic of water within the specified themes. The teacher who designed each water-related teaching project or activity presented their work, which was simultaneously evaluated by both the participants and the researchers (Figure 1). Upon completion of the training, an assessment meeting was conducted with the teachers to discuss the activities conducted, and data collection tools were employed for posttest implementation.

Figure 1

Pictures of the activities performed by the teachers



Data Collection Tools

In order to evaluate the effectiveness of the project, Personal Information Form and Reflective Opinion Form, Water Comprehension Test, Water Literacy Scale and Water Attitude Scale developed by the researchers were used.

1. *Personal Information Form*: “Personal Information Form” developed by the researchers was used to obtain personal information by teachers.

2. *Water Comprehension Test (WCT)*: The Water Comprehension Test, developed by Akpınar et al. (2011), is a test used to measure participants’ cognitive learning levels regarding water and related topics through pretest, posttest, and follow-up measurements. It is designed to identify cognitive differences that may arise from the implemented materials. The mean difficulty of the test consisting of 24 items was 0.43 and the KR20 reliability coefficient was found to be 0.66. Test items have 4 options, 1 true and 3 false.

3. *Water Literacy Scale (WLS)*: The Water Literacy Scale, developed by Sözcü & Türker (2020), consists of 30 items and utilizes a 5-point Likert scale for rating. The scale is composed of three factors. The first factor, “water conservation” has a reliability coefficient of 0.89. The second factor, “water consciousness” has a reliability coefficient of 0.88. The third factor, “water sensitivity” has a reliability coefficient of 0.69. Overall, the scale has a high reliability coefficient of 0.90, indicating strong internal consistency.

4. *Water Attitude Scale (WAS)*: The Water Attitude Scale, developed by Çankaya (2014), is designed to assess attitudes towards water. The scale consists of a total of 14 items. The reliability coefficient determined for the scale is 0.897, indicating a high level of internal consistency.

5. Reflective Opinion Form: The Reflective Opinion Form was utilized for evaluating the training process on water literacy among teachers. It consisted of three open-ended questions developed by the researchers. When preparing the Reflective Opinion Form, special attention was given to ensure clarity of the questions, avoiding leading questions, refraining from asking multidimensional questions, and organizing the questions in a logical manner (Yıldırım & Şimşek, 2011). The questions for the Reflective Opinion Form were formulated by drawing upon similar studies (Akpınar et al., 2011; Çankaya & Filik-İşçen, 2015). The formulated questions underwent revision and refinement with input from three experts in the field, comprising of academicians and science teachers. Subsequently, a pilot implementation was conducted with seven randomly selected teachers specializing in classroom teaching who voluntarily participated and displayed an interest in water-related issues. Based on the feedback received from these teachers, the comprehensibility and difficulty levels of the questions were determined, leading to the finalization of the Reflective Opinion Form through necessary adjustments.

Data Collection

As part of the data collection process, the Personal Information Form was administered to all participants online prior to the training. The Water Comprehension Test, Water Literacy Scale, and Water Attitude Scale were administered to participants both before and after the training. Lastly, the Reflective Opinion Form was administered to participants after the completion of the training. The research data was collected via the Zoom Cloud Meetings program due to COVID-19.

Analysis of Data

In the analysis of the data collected from the WCT, WLS, and WAS, quantitative analysis techniques were employed. The IBM SPSS software package was used for the analysis of the quantitative data. A significance level of 0.5 was adopted for the evaluation of the results. Data obtained from the Reflective Opinion Form were analyzed using the content analysis method. This involved coding the data, identifying themes, calculating the consensus reliability of the codes and themes, and organizing and interpreting the findings. Frequency and percentage calculations were also conducted for the codes and themes. In order to ensure the validity of the research, (1) The data coding and how to reach the conceptual category within the data analysis process are explained in detail (Hruschka et al., 2004), (2) The results obtained in the research for each of the categories, examples from student opinions were selected and presented in the findings section (Roberts & Priest, 2006) and (3) An attempt was made to ensure consistency between related studies in the comments. Two independent experts analyzed data to ensure the reliability of the study. Expert opinions were calculated using the formula $[\text{Agreement} / (\text{Agreement} + \text{Disagreement}) \times 100]$ (Miles & Huberman, 1994). The average reliability among coders was 93%. Although each data collection tool was evaluated separately during analysis, the results were interpreted collectively. As a result, the water comprehension levels, water literacy levels, and attitudes of the teachers towards water literacy were determined, and any changes in these aspects throughout the training process were analyzed (Yıldırım & Şimşek, 2011).

Results

Shapiro Wilk Test Results

The Water Comprehension Test (WCT), Water Literacy Scale (WLS), and Water Attitude Scale (WAS) were administered as pre- and post-measurement tools to examine potential differences in participants' cognitive learning levels regarding water and related subjects, with consideration of the materials used. To assess data normality, the Shapiro-Wilk test was performed. The results revealed that the WCT data exhibited a normal distribution, whereas those from the WLS and WAS did not (Table 3). Consequently, for the comparisons between pretest-posttest total score values, the dependent sample T-test (paired sample t-test) was utilised for data with a normal distribution, whereas the Wilcoxon Signed Ranks test, a non-parametric test, was employed for data that did not meet the assumptions of normality.

Table 3

Results of the Shapiro-Wilk Test to Determine Whether the Scores from the WCT Show Normal Distribution

	Test	Statistic	df	p
WCT	Pretest	0.927	17	0.193
	Posttest	0.903	17	0.075
WLS	Pretest	0.946	17	0.394
	Posttest	0.886	17	0.039
WAS	Pretest	0.741	17	0.000
	Posttest	0.754	17	0.001

The Findings Concerning the Water Compression Test (WCT)

In the study, the WCT was administered to assess the water comprehension levels of elementary teachers. The pretest and posttest total scores of the research group were found to exhibit a normal distribution ($p > .05$). Consequently, the paired sample t-test was employed to analyze the data, and the results are presented in Table 4.

Table 4

Independent Groups t-test Findings on the WCT Pretest-Posttest Results of the Group

	Test	N	X	SS	SE	Sd	t	P
WCT	Pretest	17	15.327	2.399	0.581	16	-1.110	0.283
	Posttest	17	16.156	1.934	0.469			

According to the analysis results, it was found that there is no statistically significant difference in the water comprehension results of the elementary teachers ($t_{(17)} = -1.110$; $p > .05$). However, when considering the mean rank and total difference scores, it can be observed that this difference tends to favour the positive ranks, indicating higher posttest scores. Upon examining the data, it was determined that the average posttest scores increased, although the difference did not reach statistical significance.

The Findings on the Water Literacy Scale (WLS)

The study employed WLS to assess classroom teachers' water literacy levels. A comparison was made between the scores of the research group before and after the training to determine whether there was a significant difference in the teachers' water literacy levels. As the data from the Shapiro-Wilk test did not follow a normal distribution, the Wilcoxon Signed Ranks test, a non-parametric test, was used for the analysis. The comparison of pretest and posttest scores of the teachers on the WLS is presented in Table 5, and the results of the Wilcoxon Signed Rank test for the comparison of posttest and pretest scores on the WLS are presented in Table 6.

Table 5

Comparison of Elementary School Teachers' Pretest and Posttest Scores of the WLS

	N	X	SS	Z	P
Pretest	17	121.94	11.576	-0.639	0.523
Posttest	17	124.23	8.637		

Table 6

Wilcoxon Test Results for the Comparison of the WLS Posttest-Pretest

	N	Mean Rank	Rank Total	Z	P
Negative Rank	8 ^a	7.88	63.00	-0.639 ^a	0.523
Positive Rank	9 ^b	10.00	90.00		
Equal	0 ^c				
Total	17				

- a. Posttest water attitude < pretest water attitude,
- b. posttest water attitude > pretest water attitude,
- c. posttest water attitude = pretest water attitude

The analysis results indicate that there is no statistically significant difference in the water literacy levels of the elementary teachers, as determined by the Wilcoxon Signed Ranks test ($Z_{(17)} = -0.639$, $p > .05$). However, when considering the mean rank and totals of the difference scores, it is observed that the positive ranks, representing the posttest scores, are slightly higher. Upon examining the data, it can be observed that there is an increase in the posttest averages, although this difference did not reach statistical significance.

The Findings Related to the Water Attitude Scale (WAS)

In the study, the WAS was administered to assess elementary teachers' water attitudes. The pretest and post-test scores of the teachers on the WAS were compared to determine if there was a significant difference before and after the education. Because the data did not follow a normal distribution according to the Shapiro-Wilk test, the nonparametric Wilcoxon Signed-Ranks test was used for the analysis. The comparison of the pretest and post-test scores of the elementary teachers on the WAS is presented in Table 7.

Table 7*Comparison of Pretest and Post-test Scores of Elementary Teachers on the WAS*

	N	X	SS	Z	P
Pretest	17	60.970	6.161	-0.228	0.820
Posttest	17	60.680	6.242		

The results of the Wilcoxon Signed Ranks Test for the comparison of the WAS post-test and pretest scores are presented in Table 8.

Table 8*Wilcoxon Test Results for the Comparison of Posttest and Pretest Scores on the WAS*

	N	Mean Rank	Rank Total	Z	p
Negative Rank	8 ^a	7.00	56.00	-0.228 ^a	0.820
Positive Rank	7 ^b	9.14	64.00		
Equal	2 ^c				
Total	17				

- a. Posttest water attitude < pretest water attitude,
 b. posttest water attitude > pretest water attitude,
 c. posttest water attitude = pretest water attitude

The analysis results indicate that there is no statistically significant difference in the water attitude scores of the elementary teachers, as determined by the Wilcoxon Signed Ranks test ($Z_{(17)} = -0.228$, $p > .05$). However, when considering the mean rank and totals of the difference scores, it is observed that the positive ranks, representing the post= test scores, are slightly higher.

The Findings of the Relationships Between Water Comprehension Levels, Water Literacy and Water Attitudes

Within the scope of the research, Spearman rank-order Correlation were calculated in order to investigate whether the education given for water literacy has an effect on the relationships between the water comprehension levels, water literacy and water attitudes of the teachers. The findings are presented in Table 9.

When examining the relationship between variables, the correlation coefficient can be categorized as follows: weak if it falls between 0-0.29, moderate if it ranges from 0.30-0.64, high if it ranges from 0.65-0.84, and very high if it falls between 0.85-1 (Kılıç & Ural, 2018).

Based on the Spearman rank-order correlation analysis, a statistically significant, positive, and moderate correlation was found between the posttest scores of the WLS and the WAS ($r_s = .503$, $p = .040$).

Table 9

Spearman Rank-order correlation results on water comprehension level, water literacy and water attitudes

Levels of Water Comprehension			Water Literacy	Water Attitudes
Levels of Water Comprehension	Spearman's rho	—		
	df	—		
	p-value	—		
Water Literacy	Spearman's rho	.153	—	
	df	15	—	
	p-value	.557	—	
Water Attitudes	Spearman's rho	-.250	.503	—
	df	15	15	—
	p-value	.334	.040*	—

*Correlation is significant at the 0.05 level (2-tailed).

The Findings Concerning the Reflective Opinion Form

In order to examine the impact of water literacy training on teachers' opinions, the "Reflective Opinion Form" was administered. The responses provided by the teachers to the form's questions are presented in Table 10-12, along with sample sentences reflecting their opinions.

Table 10

The Content Analysis of the Responses to the Question "Did the Education you Received Help you Learn about Water Literacy? If your answer is yes, could you briefly share your newly acquired information?" is as follows:

Theme	Codes	Frequency	Percent
Water Knowledge	Water Cycle	4	19.04
	Water Saving	3	14.28
	Water Footprint	3	14.28
	Water Pollution	2	9.52
	Chemistry of Water	2	9.52
	Blue, Green, Gray Water	1	4.76
	Water Literacy	1	4.76
	Applicability of Water in Classroom	1	4.76
	Uses of Water	1	4.76
	Water-Health Relationship	1	4.76
	Water Distribution in the World	1	4.76
	Correct Use of Water	1	4.76
	Total	21	100

As can be seen in Table 10, all the teachers (100%) stated that they had knowledge about water literacy with the education they received. The answers given to this question were categorized under the theme of "water knowledge". They stated that they learned about the water cycle (19.04%), water saving (14.28%), water footprint (14.28%), water

pollution (9.52%) and water chemistry (9.52%). With this finding, it can be thought that the teachers gained knowledge about water literacy with the education they received. Sample sentences of teachers' opinions are given below:

T1: Yes. I learned a lot of new information about the chemistry of water, the water cycle, and water conservation.

T7: Water has always been a subject that interested me, and the concrete examples given by my teacher friends during the implementation were extremely useful in terms of implementation in the classroom.

T17: Yes, from the selection criteria of drinking water to the correct use of water, it was very instructive in terms of examples that could increase my students' awareness about water pollutants and especially about water.

Table 11

The Content Analysis of the Responses to the Question "Will Your Water Use Pattern Change After the Training you Received? Could you Explain your Answer?" is as follows:

Theme	Codes	Frequency	Percent
Water Usage	Careful use of water	13	76.47
	Drinking water preference	1	5.88
	I used caution before	3	17.64
	Total	17	100

When examining Table 11, it is evident that 14 teachers (82.35%) stated that their water usage patterns would change after receiving the training, while 3 (17.64%) reported already using water carefully prior to the training. The responses provided for this question were categorised under the theme of "water usage". Specifically, 13 teachers (76.47%) stated that their overall water-use habits would change after the training, while one teacher (5.88%) mentioned a change in their preference for drinking water. Additionally, 3 teachers (17.64%) stated that they were already using water carefully before the training. Here are sample sentences reflecting the opinions of the teachers:

T5: I can say that the way I use water has changed, thanks to the education I received.

T17: We have already started diversifying the water we use for drinking. We started to implement the points we could save in the family first.

T12: I used to use it carefully, but now I take more care.

When examining Table 12, it is seen that all the teachers (100%) expressed their intention to organize various activities in their schools to enhance the water literacy of students after receiving the training. Not a single teacher mentioned that they did not plan to conduct any activity. The responses provided for this question were categorized under the theme of "water implementation". The responses provided for this question were categorized into different themes. The most common themes included applying what they have learned (22.22%), conducting experiments and activities to raise awareness (22.22%), and organizing seminars (16.66%). Here are sample sentences reflecting the opinions of the teachers:

T1: I did many activities at school. We organized an exhibition called "THE WORLD'S MOST IMPORTANT TOPIC" to showcase the work done for all students. We held a show in the school conference hall, and our District Director of National Education participated. After the training, I will continue to develop this project.

T3: *I will always include awareness activities about water literacy in my family, social environment, class, and school.*

T7: *Within the scope of this project, we collected waste oil throughout the school and delivered it to the municipality, and from now on, we want to do this regularly at regular intervals.*

T5: *I want to be conscious about water use and do social responsibility projects to improve it.*

Table 12

The Content Analysis of the Responses to the Question “What are the Water Practices you Plan to do in order to Improve the Water Literacy of the Students, Apart from the Project you did Within the Scope of the Education at Your School After the Education you Received?” is as follows:

Theme	Codes	Frequency	Percent
Water Implementation	Applying what I learned	4	22.22
	Conducting experiment and activities to raise awareness	4	22.22
	Seminar	3	16.66
	Show	2	11.11
	Making a social responsibility project	2	11.11
	Exhibition	1	5.55
	To follow the publications on water	1	5.55
	Water day event	1	5.55
	Total	18	100

Determined from the answers of the teachers are; after the training, they learned about the water subject, learned the properties of water, succeeded in associating the concept of water with course achievements, increased water awareness, increased water literacy levels, wanted to do more projects on water literacy in their schools, and thought of providing trainings by reaching more people.

Discussion and Conclusion

Sustainability education aims to develop individuals' skills in protecting ecosystems, using natural resources efficiently and leaving a sustainable life for future generations (UNESCO, 2014). Sustainability education, in line with the United Nations Sustainable Development Goals (SDGs), enables individuals to gain awareness about environmental, economic and social sustainability issues. In this context, protecting water resources is a fundamental element of sustainability. In particular, the limited and exhaustible nature of water resources necessitates individuals to be aware of water management and use (Middlestadt et al., 2001).

The importance of water, an essential element for sustaining life on Earth, is being increasingly recognized. Moreover, this significance becomes even more pronounced considering the global challenges such as limited access to clean and usable water, rapid population growth, mismanagement of water resources, and the alarming pollution of water due to industrialisation. Issues related to water scarcity and insufficiency emerge as critical problems impacting societies (Mohapatra & Bhadauria, 2009). In this context, education

plays a vital role in instilling habits and practices for responsible water use and conservation. Nasr (1998) defines the purpose of water education as cultivating individuals' sense of responsibility towards water, raising their awareness about water-related issues, and influencing their behaviors and actions to promote water conservation. Having sufficient knowledge about water is also significant for shaping the future of water management, as it guides decision-making at both individual and societal levels (Covitt et al., 2009). Therefore, it has become crucial to ensure the preservation of clean and accessible water for future generations and to seek solutions for its efficient utilization. In line with this perspective, this research aimed to enhance teachers' water literacy through water education and the implementation of projects and activities. The training provided in this study aimed to induce behavioral changes among teachers in terms of their cognitive understanding, attitudes, and psychomotor skills related to water.

According to the findings, there were no significant differences in the water comprehension levels of elementary teachers before and after the water training provided. This could be attributed to the fact that the educational content in our study covered topics already familiar to the teachers. However, when examining the mean scores, the posttest results were higher than the pretest results. This suggests that the water education had a positive impact on improving the teachers' understanding of water. The increase in scores after the implementation indicates that the teachers' knowledge about the concept of water has improved as a result of the training provided. This finding aligns with a few existing studies on teachers' water knowledge conducted worldwide (Fortner & Meyer, 1989; Beiswenger et al., 1991; Fortner & Corney, 2002; Tal, 2004). Similarly, Cappellaro et al. (2011) observed an increase in mean scores in water comprehension tests after implementing water-related activities to raise awareness among adults, although no significant difference was found. In a study by Beiswenger et al. (1991), it was found that teachers, in some cases, may lack the necessary education and understanding to significantly influence conceptual changes in their students. However, the teachers claimed to have sufficient knowledge in certain aspects related to water. It was also concluded that the education curriculum did not prioritize this subject matter.

According to Wang et al. (2019), water literacy should encompass variables such as water knowledge, attitude, and appropriate water behavior. This research aims not only to enhance teachers' understanding of water but also to change their attitudes and behaviors towards solving everyday problems related to water. The results from the water attitude scale, administered to assess teachers' attitudes towards water before and after the water training, showed no significant differences in attitude levels. However, upon analyzing the mean scores, it was observed that the posttest results were higher than the pretest results. This suggests that the water education provided had a positive impact on teachers' attitudes towards water. Similar findings were reported in a study by Akpınar et al. (2011), which found that a 25-hour water awareness project resulted in a significant increase in participants' perceptions of water and their attitudes towards the environment. Birch & Schwaab (1983) conducted a study involving experimental and control groups, where teachers in the experimental group received training on water conservation. The study concluded that the attitudes of teachers in the experimental group towards water conservation were significantly more positive than those in the control group. It is worth noting that personal traits, such as attitude and behaviour, are challenging to change (Yağcı, 2017). In a similar study conducted by Çankaya (2014), limited changes were observed in the water attitudes of pre-service teachers, and it was suggested that more time was needed for attitudes to change. Based on this research, it can be inferred that a longer training period is necessary to further improve the water attitudes of elementary teachers.

Tosun et al. (2022) emphasized the insufficiency of information regarding water literacy and water conservation in education based on their work with teachers and students. They highlighted the significance of schools in promoting water literacy. Another study conducted by Çakmak et al. (2018) found that the knowledge level of prospective teachers regarding water was at a moderate level. These findings suggest that water literacy training for teachers, both during their tenure and before graduation, should be given greater importance. The results of our study, indicating an increase in the water literacy levels of teachers through such training, support the notion that these trainings should be more frequently incorporated into the teachers' training processes.

In several studies, it has been emphasized that water education should not be limited to early age groups but should also include teachers and parents, as evident in this study (Fisk, 2016). Xu et al. (2019) have highlighted that water knowledge and water retention are key factors influencing water behavior. Based on this, it can be inferred that individuals with positive water retention and high water knowledge are more likely to have higher water literacy levels. Therefore, it is important to promote water sustainability and raise awareness about the significance of water for our world. This can be achieved by incorporating water-related activities into educational environments, thereby fostering the development of conscious generations with a strong understanding of water. The education of teachers stands out as one of the most effective ways to enhance students' water literacy (Freitas et al., 2024).

In this research, the impact of water literacy education on teachers' perspectives was also examined. The results showed that teachers gained knowledge about various aspects of water literacy, including the water cycle, water conservation, water footprint, water pollution, and water chemistry. They also reported changes in their water usage behaviours. The teachers highlighted the importance of concrete activity examples provided during the education, as it enabled them to apply the knowledge effectively and raise awareness among their students. These findings suggest that water literacy education is effective in shaping teachers' perspectives. The literature supports the findings of this study. Ursavaş (2020) emphasized the importance of incorporating practices with meaningful content in the education process to develop water literacy across different dimensions. Similarly, Brody (1995) stated that the most effective and sustainable approach for fostering water literacy is through educating individuals in this domain. Teachers, being the key influencers in shaping future generations, have a significant role and responsibility in this regard. In this context, improving teachers' water literacy not only increases individual awareness levels but also supports social transformation through classroom practices. Türkiye is among the countries experiencing water stress, and this makes water literacy even more important. Limited water resources, increased risk of drought, and water pollution make it necessary for individuals to be aware of these issues. Although the current education curriculum in Türkiye includes water issues to a certain extent, the findings of this study indicate that more comprehensive approaches are needed to improve teachers' water literacy levels. In particular, it is seen that teachers should include more water literacy activities in their classroom practices. In this context, it is recommended that topics such as the water cycle, water conservation, water pollution, and water footprint be included in education programs in a more integrated manner.

Upon analyzing the responses provided by the teachers in the Reflective Opinion form, it is evident that they acquired knowledge about water through the training. They learned about the properties of water and successfully connected the concept of water with the outcomes of their courses. Furthermore, their water awareness and water literacy levels have increased as a result of the training. The teachers expressed their desire to undertake

more water literacy projects in their schools and demonstrated enthusiasm for reaching out to a wider audience and providing water education.

Based on the findings of this research, it is evident that there is a growing need for further studies on water education, considering the increasing importance of water in our daily lives. The limited number of existing studies also highlights the urgency of prioritizing research in this field. The results obtained from the collaborative project between the District Directorate of National Education and the Faculty indicate that the training provided to 17 elementary school teachers has significantly contributed to their knowledge, awareness, and competencies in water literacy. Moreover, the teachers implemented various projects with their students as part of the project, gaining valuable knowledge and experience in water literacy practices within educational settings. The research results suggest that the training conducted within the water literacy project has proven to be effective, and extending it to a larger group from different disciplines through face-to-face interactions would further enhance its effectiveness. This approach would enable teachers with enhanced water literacy levels to provide training to their colleagues, parents, and students on water-related topics, resulting in greater benefits for all.

Water literacy is a multidimensional concept that aims to improve individuals' knowledge, attitudes, and behaviors regarding water resources (Wang et al., 2019). However, there are different approaches in the literature regarding the definition and scope of water literacy. For example, while some studies reduce water literacy to only the level of knowledge (Covitt et al., 2009), others approach this concept from a holistic perspective that includes knowledge, attitude, and behavioral changes (Freitas et al., 2024). The results of this study show that a positive effect is created on teachers' water knowledge levels, but attitude and behavioral changes require longer-term training. This necessitates further investigation of the concept of water literacy in the context of individual behavioral changes.

Water literacy should be regarded as an essential tool for achieving both individual awareness and societal sustainability goals (Boon, 2024). From this perspective, the results of this study demonstrate that teachers' participation in water literacy training positively influences both their knowledge levels and classroom practices. These effects can increase teachers' capacity to be role models for students on water conservation and sustainability. Although this study is limited to teachers, future studies with students, parents and different professional groups can examine the social effects of water literacy more comprehensively. Additionally, research findings show that water literacy training should be integrated into teacher training programs.

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