ROUTE
EDUCATIONAL & SOCIAL SCIENCE JOURNAL
ISSN: 2148-5518

Volume 9, Issue 3, May 2022, p. 188-202

Article Information

Article Type: *Research Article*

This article was checked by iThenticate.

Doi Number: http://dx.doi.org/10.17121/ressjournal.3164

ArticleHistory:
Received
25/03/2021
Accept
30/04/2022
Available online
05/05/2022

THE EFFECT OF AN ONLINE SUSTAINABLE DEVELOPMENT EDUCATION ON WATER LITERACY OF TURKISH MIDDLE SCHOOL STUDENTS

ÇEVRİM İÇİ YAPILAN BİR SÜRDÜRÜLEBİLİR KALKINMA EĞİTİMİNİN ORTAOKUL ÖĞRENCİLERİNİN SU OKURYAZARLIKLARINA ETKİSİ

Arzu KUCUK[1]

Abstract

The purpose of this research is to examine the effect of sustainable development teaching, which was developed for middle school students and applied in an online environment, on students' water literacy. Quantitative and quantitative research data were used in the research conducted with twenty-four 8th grade students studying in the same class for three years. Half of them participated in sustainable development education. Data were collected using a fairly new Water Literacy Scale developed by Sozcu and Turker (2020a) consisting of three sub-dimensions and a total of thirty items. This scale was applied to both students who attended and did not in the teaching approximately one year after the intervention. An open-ended questionnaire was also applied in the second session to explain the result for water consciousness in this scale data. It was revealed that online education for sustainable development goals had permanent effects on the water literacy of the students. However, the reason for the low scores in water consciousness, which is the second sub-dimension was due to the lack of a design in the intervention program that would strengthen the cognitive structure for the nature of water.

Keywords: Sustainable Development, Module Teaching, Water Literacy, Online

Özet

Bu çalışma, ortaokul öğrencileri için geliştirilen ve çevrim içi ortamda uygulanan bir sürdürülebilir kalkınma eğitiminin öğrencilerin su okuryazarlıklarına etkisini incelemek amacıyla yürütülmüştür. Nitel ve nicel araştırma verilerinin birlikte kullanıldığı araştırmanın çalışma grubunu üç yıl boyunca aynı sınıfta okuyan sekizinci sınıf öğrencileri oluşturmuştur. Bunların yarısı bir yıl önceki sürdürülebilir kalkınma eğitime katılmıştır. Veriler, Sözcü ve Türker (2020a) tarafından geliştirilen ve üç alt boyuttan toplam otuz madde içeren oldukça yeni bir Su Okuryazarlığı Ölçeği ile toplanmıştır. Bu ölçek eğitime katılan ve katılmayan öğrencilere çevrim içi öğretimin tamamlanmasından bir yıl sonra uygulanmıştır. Eğitime katılanlar lehine

[1] Ministry of National Education, Yamanturk Middle School, Rize, Turkey. arzukucuk@gmail.com, 0000-0001-8933-8179

ölçeğin su bilinci boyutunda ortaya çıkan sonucu açıklamak için öğrencilerle açık uçlu bir anket çalışması yapılmıştır. Bunun sonucunda sürdürülebilir kalkınma amaçlarına yönelik ve çevrim içinde yapılan uygulamaların öğrencilerin genel anlamda su okuryazarlıklarına olumlu yansıdığı belirlenmiştir. Buna karşın öğrencilerin ölçeğin ikinci boyutu olan su bilincine yönelik okuryazarlık puanları ise yüksek seviyede çıkmamıştır. Bu sonuçtan hareketle, çevrim içi ortamda uygulanan sürdürülebilir kalkınma modülünün suyla ilgili bilişsel yapıyı güçlendirecek bir içeriği de kapsayacak şekilde yeniden yapılandırılması önerilmiştir.

Anahtar Kelimeler : Sürdürülebilir Kalkınma, Modüler Öğretim, Su Okuryazarlığı, Çevrim İçi

INTRODUCTION

In the 21st century, important developments in science and technology are on the agenda for human beings. Things that are shared can sometimes be surprising to the benefit of humanity, sometimes beyond the limits of a normal person's mind. Undoubtedly, it is difficult to evaluate this as the fact that science and technology always provide benefits. There is a fierce struggle to increase human well-being and sometimes to be ahead of others globally. One harmful and untargeted situation is global climate change or global warming. It is an issue that has been talked about by almost all parts of society in the past decade. Nowadays the increase in global surface temperatures began to be felt directly. On the other hand, the predictions that it will reach 2°C in the early 2050s have started to make people think brooding. Although it is difficult to set a limit in the long term, a partial consensus has been reached on the need to change the pace and method of development. The sustainability of development is more valuable than its continuity. This situation also imposes important duties on the education systems, which are the most basic dynamics that shape society. In this context, specific targets for sustainable development have been started to be set in school curricula. It is suggested that understanding the usage of water, the health implication of water quality, and the overall impacts as a result of water shortage or extreme precipitation should all be part of the curriculum. Dean, Fielding, and Newton (2016) put forward that higher levels of water-related knowledge among the public lead to more numerous and productive discussions and also public engagement in both informal and formal processes.

This concept, namely sustainable development, has three dimensions environment, social and economic (Weinberger, Rankine, Amanuma, Surendra, & Van Hull, 2015). The United Nations published Sustainable Development Goals (SDGs) in 2015 (UN, 2015). The goals associated with the three dimensions have begun to be reflected in the school curriculum formally. As an additional action strategy, informal education-based teaching is also used to achieve sustainable development goals. SDGs for 2030 has been expanded to “ensure availability and sustainable management of water and sanitation for all”. One of the SDGs has been defined as "Access to Healthy Water / Life in Water". According to the 2019 World Water Report prepared by the United Nations-affiliated UNESCO, "two billion people do not have regular access to clean water resources, 4.3 billion people do not use sanitary facilities", and expresses the disasters that water waste will bring along”. This goal brings to mind water literacy, which is frequently encountered in the literature in recent years. In short, there is a close relationship between one of the SDGs and literacy. Therefore, to use water resources sustainably and to deliver them to future generations, it is clear that individuals and societies with high literacy levels are needed.

In this context, since water cannot be added to the natural water cycle from outside, the best thing to do is to raise individuals who have a positive attitude about using water consciously and saving. In this way, it is possible to use water sustainably, protect it, and deliver it to future generations in a healthy and sufficient amount. In this respect, it is known that water-literate individuals have these qualities. Water literacy appears with different definitions in the literature and there is no consensus on the definition. Su, Chen, and Wang (2011) explained it as "It is the culmination of water-related knowledge, attitudes, and behaviors, setting apart its importance and uniqueness from other more

commonly used labels such as ecological or environmental literacy" (p. 518). Wood (2014) says that "I suggest that a water literate citizen is someone who is informed and knowledgeable about water use and issues and is applying this knowledge to their values and their actions, whether that is achieved actively or subconsciously" (p. 7). Wang, Chang, and Liou (2019) also said "Water literacy should include variables such as water knowledge, attitude, and appropriate water behavior." Otaki, Sakura, and Otaki (2015) defined water literacy as "the ability to feel familiar with water, get actively involved in water and face the issue of water as one's issue. Being water literate means understanding how the water we use daily is delivered and treated, as well as knowing the quality and safety of that water, how much water we use daily, and exactly what we use it for" (p. 36). These definitions and knowledge are set to highlight that the concept of water literacy is multi-faceted and complex. There is a good framework for the concept of water literacy derived from the literature review (see, McCarroll & Hamann, 2020).

They also conceptually divided water literacy into three parts practical water literacy, live water literacy, and social water literacy. Practical water literacy is having healthy water for life, distinguishing unhealthy water, and understanding the importance of water. However, living water literacy is the ability to master the necessary and sufficient use of water in the home and social life and the knowledge of water recycling. Ultimately, social water literacy is a process of transformation into individuals who are concerned about the future of water, can produce solutions to water problems, and adopt a holistic water approach that contributes to taking precautions.

The literature includes studies in four main areas: efforts to define water literacy, efforts to describe K-16 student water knowledge, efforts to describe adult water knowledge, and approaches to improve water literacy (Hui-Shuang, 2018; Sozcu, Yuksel, Tuna, & Sagir, 2022; Sozcu & Turker, 2020b) (Moreno-Guerrero, Romero-Rodríguez, López-Belmonte, & Alonso-García, 2020) (Wang, Chang, & Liou, 2019). In the framework of water education, attention was drawn to the multidisciplinary nature of water and the concept-skill-interaction relationship was emphasized (Brody, 1995). Water literacy can be explained not only as knowing water but also as taking action with water knowledge to support sustainability.

Based on the explanations made up to this point, the value of building a society that has basic knowledge about water is concerned about water, and strives for it by raising water literate individuals becomes clear. Now, it is important to plant the seeds of consciousness and attitude that starts in the family and continues throughout life, but the point of how to structure it with education is still controversial. In this context, science, media, mathematics, technology, water, and other literacy and how to develop those continue to form the agenda of educators and researchers. It is more economical to implement an interdisciplinary sustainable development education by its nature, rather than an education that focuses only on water literacy. Moreover, as mentioned in the previous paragraphs, one of the goals of sustainable development is directly related to water. In this respect, it is a problem that needs to be emphasized and explained how a sustainable development education employed for middle school students affects their water literacy in the long run. In a theoretical sense, a three-dimensional education, namely environment, social and economic, has the potential to affect children's water literacy in terms of their water-oriented goals. On the other hand, it is clear that two of the sustainable development goals - Accessible Clean Energy / Industry Innovation and Infrastructure and Sustainable Cities and Communities / Combating Climate Change - are directly and/or indirectly related to water literacy (Kucuk & Burkaz Ekinci, 2021). In this context, it is natural to expect that the activities to be carried out within the scope of sustainable development education and towards these three goals will have an impact on water literacy.

There is a large body of work that investigates attitudes and knowledge of alternative water resources, like recycled wastewater or desalination. There are also some studies to determine how effective these programs are in terms of sustainable development goals and therefore they determined the level of attitudes, beliefs, knowledge, opinions, and behaviors of individuals at different ages (Ates, 2019; Boon, 2011; Cobanoglu & Turer,

2015; Er-Nas & Senel-Coruhlu, 2017; Sagdic & Sahin, 2016; Teksoz, Sahin, & Ertepinar, 2010) However, the measured qualities were in general and not directly associated with any literacy. The gap in this area has made it necessary to carry out the current research.

The research aimed to reveal the effect of a sustainable development education conducted in an online environment on the water literacy of middle school students who are the official science teachers of the researcher.

METHOD

This paper is part of a major project designed for sustainable development education based on a mixed research approach that combines qualitative and quantitative research. Due to the Covid-19 outbreak that started at the beginning of 2020, the teaching was carried out through online education and via the zoom application, which the students are also quite familiar with from other formal school courses. In the present study, I measured the water literacy of the students who participated in sustainable development education.

The Sample

The sample of the research consisted of the 8th grade of a public middle school located in the Çayeli district of Rize province in Turkey. These children have been studying in the same class for three years. Half of these students (7 girls and 5 boys) selected by purposive sampling, participated in the training. It is preferred when it is desired to work in one or more special cases that meet certain criteria or have certain characteristics (Cresswell, 2003). In this context, students who had an informal learning experience in previous years and fully participated in the online classes at the school were selected. In this way, all of them participated in the study voluntarily. In addition, a questionnaire was applied to the other twelve students who did not participate or lacked participation in the teaching to support the possible impact of sustainable development education on water literacy. In this way, the scores of both groups were compared.

Data Collection and Analysis

The data were collected in two different sessions. Firstly, water literacy levels were measured, and secondly, an open-ended questionnaire was conducted to explain the possible gaps in the water literacy scale results.

"Water Literacy Scale" designed by Sozcu and Turker (2020a) was used as a basic data collection tool. It has three sub-dimensions as water saving, water consciousness, and water sensitivity. There are 30 items on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). The lowest score that can be obtained from the scale is '30' and the highest score is '150'. Cronbach Alpha reliability value of the scale was found to be .89. I collected the data in Jan 2022, with the partial disappearance of the Covid-19 epidemic and the students starting face-to-face learning in schools. I collected my data in a course in which all students participated and did not participate in sustainable development education. The water literacy data obtained in this study were calculated in total and in three sub-dimensions separately for the scores of all students who participated and did not participate in online sustainable development teaching. For this purpose, I used a t-test to explain the relationship between the descriptive statistical values of the data and the scores of both groups. The data are visualized with tables and graphs.

Now, an open-ended questionnaire was applied to the same students in another session to explain the low scores of the students in the "water consciousness" sub-dimension of the water literacy scale. In this survey, a total of six questions were asked to the students. In this way, they were asked (i) to write the names of organizations on water (if know), (ii) write the monthly water consumption in their home (if know), (iii) to explain their experience of reusing water at home or outside, (iv) to explain how water is formed and (v) to explain what water consumption is and finally (vi) to write ten words related to the concept of water. The obtained data were analyzed by calculating the frequency values for the first three questions. In addition, content analysis was conducted for the

analysis of the other three open-ended questions. In the last question, approval was obtained from another science education expert for the reliability confirmation for the creation of codes and categories. In this process, the other expert analyzed the question in an independent environment, and a consensus was reached for the code and category confirmation in the short meeting held afterward. In this classification, categories with only one code are not included in the list.

The teaching method and content analysis of the sustainable development module

In this study, online sustainable development education, whose effect on water literacy was investigated, was designed by another researcher (Burkaz-Ekinci, 2021). In the current study I, also the formal science teacher of the class played a facilitating role by establishing a continuous communication network with the students and their parents. Detailed information about sustainable development education, which was finalized after the pilot study by taking expert opinions in the subject area (Kucuk & Burkaz Ekinci, 2021), is included in the doctoral thesis of the other researcher (Burkaz-Ekinci, 2021). However, in the current paper, the content of sustainable development education is briefly introduced. A total of 10 teaching modules were designed within the scope of sustainable development. The module took a total of eighteen hours. The teaching of the module was done by the other researcher. Each of these is designed for specific sustainable development goals. For example, the content analysis of the 8th module for "Access to Healthy Water/Life in Water" on water literacy and the related course learning outcomes are below.

Table 1

The sample content analysis of the sustainable development module

Course Number	Sustainable Development Goal	Time	Course Outcomes
8	Access to Healthy Water/ Life in Water	40'+40'	8.1. Based on the information that "According to the 2019 World Water Report prepared by UNESCO, which is affiliated to the United Nations, two billion people do not have regular access to clean water resources, 4.3 billion people do not use sanitary facilities", they express the disasters that water waste will bring along.

In the teaching process, the 5E model of constructivist learning was used. As an example, the teaching process within the scope of course number 8 is explained below.

In this module, students are made to realize that access to clean and healthy drinking water is a fundamental human right, how harmful chemicals and garbage affect the quality of water, that water is a rich ecosystem for many species, and that persistent pollution will endanger many species. Instead of the water treatment plant that is planned to be taken for the treatment of dirty water, a video about how the water treatment is carried out is watched because the teaching was online due to the epidemic. Then, an experiment is conducted to show/see how the dirty water is cleaned. Students are expected to fill in the designed V diagram in line with the experiment done in the lesson. In addition, the information note titled "A Little Information About Water" was shared in the lesson and it was presented with striking information about saving water. In the evaluation phase of the course, to encourage students to be careful when using water, they were asked to follow the water meter in their home and tabulate the previous data with the data after tooth brushing. In this way, they are expected to see that the difference in the meter is small if water is used carefully.

RESULTS

Water Literacy Scale Results

Within the scope of this research, statistical values and also independent samples test results were calculated from the sub-dimensions of the water literacy scale of the

students who regularly joined in the sustainable development teaching (JP) held in the online environment every week or who did not (NJP), are given in table 2.

Table 2. Distribution of group statistical and t-test values of the water literacy scale

Sub-dimensions	Group	N	Mean	s	Std. Error Mean	t	df	Sig
Water-saving	JP	12	4,37	,49	,14	-1,20	22	,24
	NJP	12	4,58	,34	,10			
Water consciousness	JP	12	2,32	,72	,20	-2,54	22	,01
	NJP	12	3,06	,69	,20			
Water sensitivity	JP	12	3,66	,52	,15	-1,51	22	,14
	NJP	12	4,00	,55	,15			
Total	JP	12	3,43	,54	,15	-2,23	22	,03
	NJP	12	3,87	,42	,12			

The statistical values of the water literacy scale in Table 2 revealed that the scores of the students who joined in the online sustainable development teaching were higher both in terms of total and sub-dimension. However, according to the t-test results between the scores, a statistically significant difference was calculated in favor of the JP's in the online sustainable development teaching in the total score of the scale and only in the second sub-dimension scores. The partial decrease in the standard deviation values of the entire scale and all sub-dimensions of the JPs indicates homogeneity in terms of water literacy qualifications.

For each item in the water literacy scale, the distribution of the average scores of the JPs and NJPs in sustainable development education is in Figure 1.

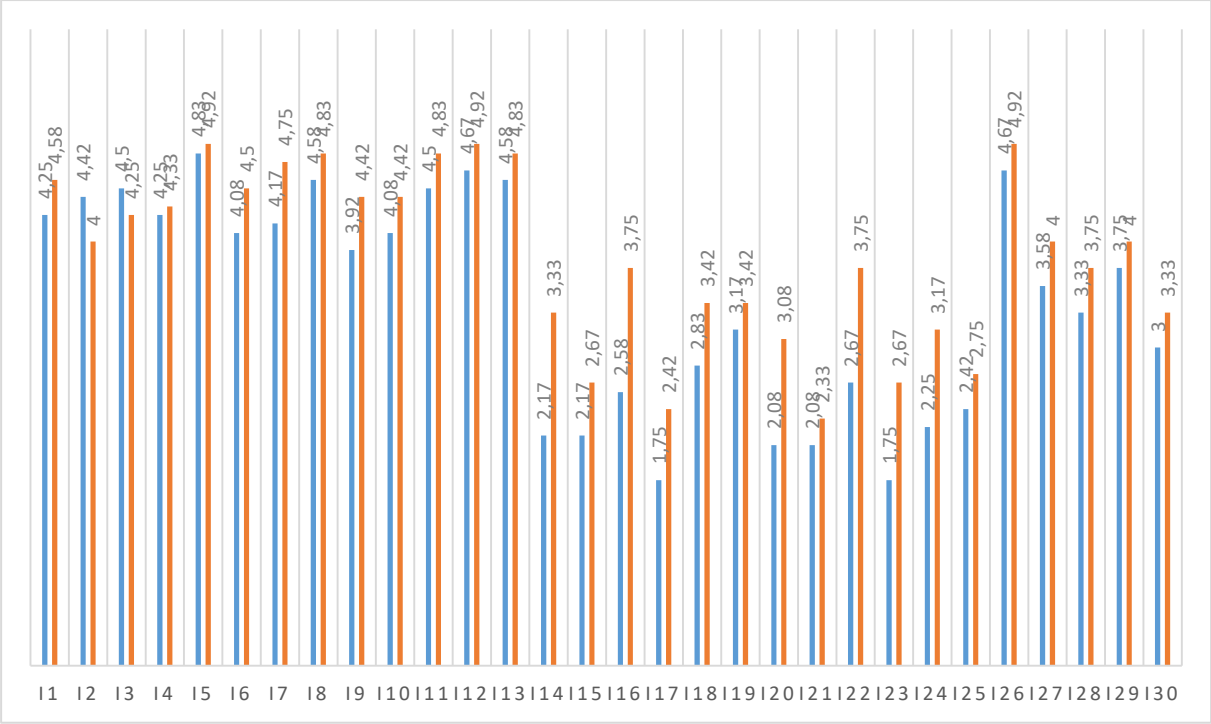

Figure 1. Distribution of the item averages of the water literacy scale of the students who attended and did not in the training

Based on this graph, the average scores of the JPs in sustainable development education in almost all items of the water literacy scale (except for items 2 and 3) were high.

However, the highest scores on the scale are related to the first dimension, water water-saving. On the other hand, the second dimension, water consciousness scores (items 14-25), is lower than the others for both JPs and NJPs. In this dimension, the scores of NJPs in teaching decreased to 1,75 (see items 17 and 23).

The open-ended questionnaire results

In the first question, the students were asked whether they knew the name of any institution or organization related to water, and if they knew, they were asked to write it. Except for one student who attended and did not participate in sustainable development education, all the others answered this question as they did not know. The student who did not attend the training wrote the answer to the state waterworks, and the participant wrote the answer to the hydroelectric power plant as the place where the water is produced.

In the second question, the students were asked whether they knew the average monthly water consumption of their house. All of the others answered this question as they did not know, except for two students each who attended and did not participate in sustainable development education.

In the third question, the students were asked whether they had any experience of reusing the water they used at home or outside (for example, pouring the water they washed the vegetables into flower pots). Only seven students who participated in sustainable development education answered this question as yes. Some of the answers are as follows.

"I pour the water with which we wash the vegetables on the flowers and the turtle"

"I pour the water that has been waiting in the bottle into the flowers"

Only three students who did not participate in sustainable development education answered this question as yes. Some of the answers are as follows.

"I water the flowers with boiled egg water",

"I pour the leftover water from the teapot onto the dishes"

In the fourth question, students were asked whether they knew how water was formed. Only four students who participated in sustainable development education answered yes to this question. One of these students explained the formation of water by referring to the water cycle in nature. On the other hand, three other students made an explanation by referring to the formation of the water molecule. Some of the answers are as follows.

"The puddles evaporate and come back as rain"

"It is formed as a result of the chemical reaction of hydrogen and oxygen"

"It is composed of hydrogen and oxygen atoms. In its pure form, it is a neutral substance and circulates on earth"

Eight students who did not participate in sustainable development education answered yes to this question. Five of these students explained the formation of water by referring to the water cycle in nature. On the other hand, three other students made explanations by referring to the formation of the water molecule. Some of the answers are as follows.

"The heat evaporates water and rises to the sky, and then turns into rain and descends to the earth again"

"It is formed by the reaction of oxygen and hydrogen atoms"

"It is formed by the combination of hydrogen and oxygen atoms"

In the fifth question, students were asked whether they knew the water cycle. Except for only four students who participated in sustainable development education, the others answered yes to this question. All of those who said yes explained the water cycle logically in short sentences. Some of the answers are as follows.

"The water in the seas and streams evaporates and rises to the sky, where it condenses and descends to the earth again"

"The waters on the earth and the water given out by living things through respiration and the water they expel through perspiration evaporate into the sky. These waters form clouds. When it cools down, it returns to the earth with various weather events such as snow and rain"

Except for three students who did not participate in sustainable development education, the others answered yes to this question. All of those who said yes explained the water cycle logically in short sentences. Some of the answers are as follows.

"The waters on the earth evaporate and go up and then descend to the earth as rain"

"The water resources on the earth evaporate, condense in the atmosphere and fall back to the earth in the form of precipitation"

In the sixth question, students were asked to write ten water-related words and briefly explain each one in one sentence. In this way, it was aimed to examine their cognitive structures about water. The answers to this question were presented comparatively in the next two tables in codes and categories by making content analysis. Table 3 includes the cognitive structures of students who do not participate in sustainable development education.

Table 3. The cognitive structures of students who do not participate in sustainable development education.

code	f	category	total f
valuable	1	source of life	14
living things	2		
nature	1		
plant	1		
soil	2		
tree	1		
human	1		
flower	1		
world	1		
life	1		
cion	1		
living	2		

animals	1		
sea	5		
saltwater	1		
stream	1		
creek	2	body of water	12
tap water	1		
health	1		
humidity	1		
evaporation	4		
water cycle	1		
cloud	1		
heat	2	water cycle	11
vapor	1		
sun	1		
condensation	1		
rain	5	type of precipitation	6
snow	1		
dry	1		
waste	2	water-saving	5
protect	1		
consumption	1		
ice	2	state change	3
freezing	1		
cooling	1	function	2
cleaning	1		
dirt	2	water sensitivity	2

Table 4 includes the cognitive structures of the students participating in sustainable development education towards the water.

Table 4. The cognitive structures of the students participating in sustainable development education toward the water.

Codes	f	category	total f
Drink	1		
Need	3		
Live	2		
World	1		
Nest	1	source of life	26
Life	8		
Plant	2		
Important	1		
Fish	2		
Flower	1		

Tree	1		
Human	2		
Cat	1		
Bottle	1		
Saving	3		
Water well	1	water sensitivity	12
Percentage	1		
Waste	1		
Pollution	5		
Consciousness	1		
Projects	1		
Renewable energy	1		
Hydroelectric power plant	2		
Geothermal power plant	1	water consciousness	11
Global warming	1		
Melting	1		
Cleaning	1		
Climate crisis	1		
Mucilage	1		
Dry	3		
Waste	1	water-saving	8
Drought	3		
Africa	1		
Glaciers	1		
Freezing	1		
Liquid	1	state change	5
Solid	1		
Gas	1		
Cycle	2		
Evaporation	1	water cycle	4
Condensation	1		
Respiratory	2	function	4
Photosynthesis	2		
Purity	1		
Oxygen	1	chemical composition	3
Hydrogen	1		
Rain	2	type of precipitation	3
Frost	1		

Based on Tables 3 and 4, it was revealed that NJPs produced a total of 46 codes. These codes, on the other hand, are classified into eight categories, from the highest frequency to the lowest, source of life, a body of water, water cycle, type of precipitation, water-saving, state change, function, and water sensitivity. On the other hand, JPs produced a total of 51 codes. These are classified into nine categories from the highest frequency to the lowest: source of life, water sensitivity, water consciousness, water-saving, state change, water cycle, function, chemical composition, and type of precipitation.

The most striking detail in this table is that JPs used more water-related words than others. Although students were asked to write up to ten words in this question, those who did not attend the training associated fewer words, an average of five words with water. Similarly, it was determined that JPs were able to produce codes for all three sub-dimensions of water literacy. On the other hand, NJPs are directed towards two sub-dimensions (except for water consciousness) and were able to generate very limited codes.

DISCUSSION

While numerous studies have addressed student conceptions of the water cycle and scientific knowledge, less is known about their attitudes and values regarding water. Water is a particularly challenging topic due to its systems complexity as well as its interdisciplinary nature (Xiong, Hao, Liao, & Zeng, 2016; McCarroll & Hamann, 2020). This research aimed to examine the effect of online sustainable development education on the water literacy of middle school students due to the Covid-19 epidemic. For this purpose, the effect of teaching attended by 12 students selected from among the students of the same school and the same class was measured. This teaching for sustainable development purposes was completed in a total of eighteen hours. About one year after the end, the newly developed water literacy scale by Sozcu and Turker, 2020a) was applied to the students who attended and did not in the teaching. In this way, it was measured that the scores of the other dimensions except for water consciousness, which is the second dimension of the three-dimensional scale, were higher (see Table 2). Cooper and Cockerill (2015) found, as compared to the public, students were less concerned about future household water supply and thoughtless about water conservation. However, the scores of all three dimensions of the participants in the teaching applied for SDGs were high. Compared to those who did not attend, the difference in total score and water consciousness sub-dimension scores was statistically significant. For this reason, there is information in the literature related to the subject area that students' water consciousness literacy is affected by their cognitive structures related to water. Pan and Liu (2018) found a positive correlation between students' groundwater systems understanding and concerns about the conservation and use of groundwater. Sadler, Nguyen, and Lankford (2017) conducted a review of research on students (K-12) missing- and misconceptions within four natural water systems (surface water, groundwater, atmospheric water, and water in biotic systems) and water in engineered systems. They noted that although water is an interdisciplinary topic, it is most commonly addressed in science classes and that the treatment across the U.S. science curriculum and standards is in no way systematic.

For this reason, open-ended questionnaires were asked to both student groups in a second session. In these questions, they were asked what they knew about water. When the answers given to these questions were examined, it was revealed that the students of both groups were similar in terms of not knowing the institutions related to water, knowing the monthly average water consumption of their houses, and explaining the water cycle. On the other hand, it was noted that the number of participants in the teaching for SDGs was high in terms of reusing water at home or outside. Only four of those who attended said yes to the question about how the water was formed, while the majority of those who did not attend said yes. On the other hand, in the explanation of the question, the participants in the SDGs directly referred to the chemical composition of the water, while the others explained the water cycle. The scores obtained in this question and the last question match each other. That is, those who participated in the training were ahead in the categories extracted from the words related to water, whereas the codes of those who did not attend were concentrated in the water cycle category.

In this context, a clear difference was found in favor of the participants in the codes produced from the expressions used by the students in the last question and the categories based on them. It was revealed that the participants of the SDGs presented codes for all three dimensions of water literacy. On the other hand, those who did not participate presented limited codes about the others except water consciousness. These data also explain why the scores of those who did not participate in the water consciousness teaching, which is the second dimension of the water literacy scale, are

low. In short, teaching towards SDGs applied in the current research is informative about water. Brody (1995) explained that water concepts were abstract and disconnected from everyday life and experience. Based on the literature, attention needs to be paid to helping students to better understand and conceptualize some unseen elements of hydrologic and hydrological systems (Benninghaus, Kremer, & Sprenger, 2018). As a natural consequence of this, the water literacy of those who participated in the teaching of SDGs was higher than the others.

Conclusion

However, the fact that content based on the chemical structure of water was not presented in the teaching led to partially high scores for water consciousness. Well-structured sustainable development education in terms of water-related goals can produce successful results without the need for an extra water literacy education. Putting the other two sustainable development goals to work has helped water literacy work in multiple ways. In future studies, the effect of a sustainable development education, which will be restructured by eliminating the relevant deficiencies, on water literacy should be re-studied.

References

Al-Naqbi, A. K., & Alshannag, Q. (2018). The status of education for sustainable development and sustainability knowledge, attitudes, and behaviors of UAE University students. *International Journal of Sustainability in Higher Education, 19*(3), 566-588. https://doi.org/10.1108/IJSHE-06-2017-0091

Ates, H. (2019). Fen bilimleri dersi öğretim programı'nın sürdürülebilir kalkınma eğitimi açısından analizi. *YYÜ Eğitim Fakültesi Dergisi, 16*(1), 101-127.

Balakrishnan, B., Tochinai, F., & Kanemitsu, H. (2020). Perceptions and attitudes towards sustainable development among Malaysian undergraduates. *International Journal of Higher Education, 9*(1), 44-51. https://doi.org/10.5430/ijhe.v9n1p44

Benninghaus, J. C., Kremer, K., & Sprenger, S. (2018). Assessing high-school students' conceptions of global water consumption and sustainability. *Int. Res. Geogr. Environ. Educ,* 27, 250–266.

Boon, H. (2011). Beliefs and education for sustainability in rural and regional Australia. *Education in Rural Australia, 21*(2), 37-51.

Brody, M. (1995). Development of a curriculum framework for water education for educators, scientists, and resource managers. *The Journal f Environmental Education, 26*(4), 18-29. https://doi.org/10.1080/00958964.1995.9941448

Burkaz-Ekinci, S. (2021). *Ortaokul öğrencileri için sürdürülebilir kalkınma eğitimine yönelik bir modül geliştirme çalışması* [Developing a module for sustainable development education for middle school students]. Recep Tayyip Erdogan University, Rize.

Cobanoglu, O., & Turer, B. (2015). Fen bilgisi ve sosyal bilgiler öğretmenlerinin sürdürülebilir kalkınma farkındalıklarının belirlenmesi. *Uluslararası Türk Eğitim Bilimleri Dergisi,* 5, 235-247.

Contini, V., & Pascual, G. E. (2010). The earth chapter: An ethical framework for feasible utopia, discourse and communication for sustainable education. *Discourse and Communication for Sustainable Education, 1*(2), 25-33.

Cooper, C., & Cockerill, K. (2015). Water quantity perceptions in Northwestern North Carolina: Comparing college student and public survey responses. *Southwest. Geogr,* 55, 386–399.

Cresswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2 ed.). Sage.

Dean, A. J., Fielding, K. S., & Newton, F. J. (2016). Community knowledge about Water: Who has better knowledge and is this associated with water-related behaviors and support for water-related policies? *PLoS ONE*, 11.

Demirbas, O. C. (2011). Coğrafya dersi öğretim programında sürdürülebilir kalkınma. *Uluslararası İnsan Bilimleri Dergisi, 8*(2), 596-615.

Derman, I. (2013). *Farklı başarı düzeylerindeki okullarda 9. ve 12. sınıf öğrencilerinin ekosisteme ilişkin öğrenme düzeyleri ve sürdürülebilir çevre bilinci ile ilişkisi [The relationship between the sustainable environmental awareness levels and learning levels of of 9th.* Ankara-and 12th grade students at school of different achievement levels [Unpublished master thesis]: Hacettepe University, Ankara. https://tez.yok.gov.tr/UlusalTezMerkezi

Engin, H. (2010). *Coğrafya eğitiminde sürdürülebilir kalkınma, sürdürülebilirlik eğitimi ve çevre eğitimi konularının kazandırılması [Teaching sustainable development, education of sustainability and enviromental education in geograpy education](Unpublished master thesis)* . Marmara University, Istanbul. https://tez.yok.gov.tr/UlusalTezMerkezi

Er-Nas, S., & Senel-Coruhlu, T. (2017). Fen bilgisi öğretmen adaylarının perspektifinden sürdürülebilir kalkınma kavramı, *14*(1), 562 - 580. http://dx.doi.org/10.23891/efdyyu.2017.22

Gomleksiz, M. N., & Kan, A. U. (2012). Eğitimde duyuşsal boyut ve duyuşsal öğrenme. *Turkish Studies - International Periodical For The Languages, Literature and History of Turkish or Turkic,, 7*(1), 1159-1177.

Hui-Shuang, H. (2018). Construction of the index system of water literacy and application in a case study of four Chinese communities. *Journal of Discrete Mathematical Sciences and Cryptography, 21*(2), 485-491. https://doi.org/10.1080/09720529.2018.1449330

Karaarslan-Semiz, G., & Teksoz, G. (2019). Developing the systems thinking skills of pre-service science teachers through an outdoor ESD course. *Journal of Adventure Education and Outdoor Learning, 20*(1), 1-20. https://doi.org/10.1080/14729679.2019.1686

Koc, G., & Demirel, M. (2008). Yapılandırmacı öğrenme yaklaşımının duyuşsal ve bilişsel öğrenme ürünlerine etkisi. *Türk Eğitim Bilimleri Dergisi, 66*(4), 629-661.

Kucuk, A. (2021). Experiences of Turkish middle school science teachers' first science fair projects coordination. *Education Quarterly Reviews, 4*(Special Issue 1), 497-512. https://doi.org/10.31014/aior.1993.04.02.262

Kucuk, M., & Burkaz Ekinci, S. (2021). What do Turkish Experts say about sustainable development goals and teaching about achieving these goals? *Education Quarterly Reviews, 4*(3), 290-303. https://doi.org/10.31014/aior.1993.04.03.339

Küçük, A., & Yildirim, N. (2021). Okul dışı öğrenme ortamlarında işlenen insan ve çevre ünitesinin akademik başarı üzerindeki etkisi. *Fen Bilimleri Öğretimi Dergisi, 9*(2), 205-264. https://dergipark.org.tr/en/pub/fbod

McCarroll, M., & Hamann, H. (2020). What we know about water: A water literacy review. *Water, 12*(2803). https://doi.org/10.3390/w12102803

Ministry of National Education[MNE]. (2018). *Curriculum of science courses of primary education institutions (3, 4, 5, 6, 7 and 8th grades).* Ankara: State Books Publishing House.

Moore, P. J. (2019). Academic achievement. *Educational Psychology, 39*(8), 981-98. https://doi.org/10.1080/01443410.2019.1643971

Moreno-Guerrero, A.-J., Romero-Rodríguez, J.-M., L.-B. J., & Alonso-García, S. (2020). Flipped learning approach as educational innovation in water literacy. *Water, 12*(2), 574.

Nitko, A. J. (2004). *Educational Assessment of Students* (4th ed.). Upper Saddle River, NJ: Pearson Education.

Novak, J., & Gowin, D. B. (1984). *Learning how to Learn.* Cambridge University Press: Cambridge.

Otaki, Y., Sakura, O., & Otaki, M. (2015). Advocating water literacy. *J. Eng. Technol,* 1, 36–40.

Ozdemir, O. (2007). Yeni bir çevre eğitimi perspektifi: "Sürdürülebilir gelişme amaçlı eğitim". *Eğitim ve Bilim, 32*(145), 23-39.

Ozsoy, R. (2019). *An investigation on the Turkish science teachers' views related to education for sustainable development (Unpublished master thesis).* Middle East Technical University, Ankara. https://tez.yok.gov.tr/UlusalTezMerkezi/

Pan, Y. T., & Liu, S. C. (2018). Students' understanding of a groundwater system and attitudes towards groundwater use and conservation. *Int. J. Sci. Educ,* 40, 564–578.

Sadler, T. D., Nguyen, H., & Lankford, D. (2017). Water systems understandings: A framework for designing instruction and considering what learners know about water. Wiley Interdiscip. *Rev. Water,* 4, e1178.

Sagdic, A., & Sahin, E. (2016). An assessment of Turkish elementary teachers in the context of education for sustainable development. *International Electronic Journal of Environmental Education, 6*(2), 141-155.

Senemoglu, N. (2010). *Gelişim, öğrenme ve öğretim: Kuramdan uygulamaya* (27 ed.). Ankara: Pegem ACademy.

Sozcu, A., Yuksel, H. K., Tuna, E., & Sagir, A. (2022). Bilim ve sanat merkezlerindeki lise öğrencilerinin su okuryazarlık düzeyleri (Istanbul örneği) [Water literacy levels of high school students in science and art centers (Istanbul example)]. *Social Science Development Journal, 7*(30), 107-120. http://dx.doi.org/10.31567/ssd.606

Sozcu, U., & Turker, A. (2020a). Development of water literacy scale. *Third Sector Journal of Social Economy, 55*(2), 1155-1168.

Sozcu, U., & Turker, A. (2020b). Examining the water literacy levels of high school students according to some variables. *Asian Journal of Education and Training, 6*(3), 569-582. https://doi.org/0.20448/journal.522.2020.63.569.582

Spiropoulou, D., Antonakaki, T., Kontaxaki, S., & Bouras, S. (2007). Primary teachers' literacy and attitudes on education for sustainable development. *Journal of Science Education and Technology, 16*(5), 443-450. https://doi.org/10.1007/s10956-007-9061-7

Su, H. J., Chen, M. J., & Wang, J. T. (2011). Developing a water literacy. *Curr. Opin. Environ. Sustain,* 3, 517–519.

Tanriverdi, B. (2009). Sürdürülebilir çevre eğitimi açısından ilköğretim programlarının değerlendirilmesi. *Eğitim ve Bilim, 34*(151), 89-103.

Teksoz, G., Sahin, E., & Ertepinar, H. (2010). Çevre okuryazarlığı, öğretmen adayları ve sürdürülebilir bir gelecek. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 39, 307-320.

Tuncer, G. (2008). University students' perception on sustainable development: A case study from Turkey. *International Research in Geographical and Environmental Education, 17*(3), 212-226. https://doi.org/10.1080/10382040802168297

Turer, B. (2010). *Fen bilgisi ve sosyal bilgiler öğretmen adaylarının sürdürülebilir kalkınma farkındalıklarının belirlenmesi[The awarness levels of science and social science prospective teachers regarding sustainable environment] (Unpublished master thesis).* On Dokuz Mayıs University, Samsun. https://tez.yok.gov.tr/UlusalTezMerkezi/

UN. (2015). *Sustainable Development Goals.* https://www.un.org/sustainabledevelopment/

United Nations. (2015). *Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All.* https://sdgs.un.org/goals/goal6.

Uzun, N. (2007). *Ortaöğretim öğrencilerinin çevreye yönelik bilgi ve tutumları üzerine bir çalışma[A study on the secondary school students' knowledge and attitudes towards the environment] (Unpublished Phd thesis).* Hacettepe University, Ankara. https://tez.yok.gov.tr/UlusalTezMerkezi/

Wang, Y. H., Chang, M. C., & Liou, J. R. (2019). Effects of water-saving education in Taiwan on public water knowledge, attitude, and behavior intention change. *Water Policy,* 21, 964–979.

WCED. (1987). *Report of the world commission on environment and development: Our common future.* http://www.un-documents.net/our-common-future.pdf

Wee, M. I., Ariffin, F. N., Ng, T. F., & Shabudin, A. F. (2017). Awareness and attitudes towards sustainable development amongst higher education students in Penang, Malaysia. In *Handbook of Theory and Practice of Sustainable Development in Higher Education* (p. 49-64). Cham: Springer. https://doi.org/10.1007/978-3-319-47877-7_4

Weinberger, K., Rankine, H., Amanuma, N., Surendra, L., & Van Hull, H. V. (2015). *Integrating the three dimensions of sustainable development: A framework and tools.* United Nations Publication. https://www.unescap.org/sites/default/files/Integrating%20the%20three%20dimensions%20of%20sustainable%20development%20A%20framework.pdf

Wood, G. V. (2014). *Water literacy and citizenship: Education for sustainable domestic water use in the East Midlands (Unpublished PhD thesis).* University of Nottingham, Nottingham.

WWF. (2010). *WWF Living Planet Report.* http://d2ouvy59p0dg6k.cloudfront.net/downloads/ wwf_lpr2010_lr_en.pdf.

Xiong, Y. J., Hao, X. R., Liao, C., & Zeng, Z. N. (2016). Relationship between water-conservation behavior and water education in Guangzhou, China. *Environ. Earth Sci,* 75, 1-9.

Yakar, F. (2005). *Sürdürülebilir kalkınma ve Karadeniz bölünmüş sahil yolunun değerlendirilmesi [Sustainable development and evaluation of Black Sea divided coastal highway] (Unpublished master thesis).* Karadeniz Teknik University, Trabzon. https://tez.yok.gov.tr/UlusalTezMerkezi/

Yilmaz-Yildiz, D. (2006). *İlköğretimde çevre eğitimi için yöntem geliştirme [To plan a method for ecology instruction at primary school] (Unpublished master thesis).* Marmara University, Istanbul. https://tez.yok.gov.tr/UlusalTezMerkezi/

Yin, Y., Vanides, J., Ruiz-Primo, M. A., Ayala, C. C., & Shavelson, R. J. (2005). Comparison of two concept-mapping techniques: Implications for scoring, interpretation, and use. *Journal of Research in Science Teaching, 42*(2), 166-184.

Zachariou, A., & Valanides, N. (2006). Education for sustainable development: The impact of an out-door program on student teachers. *Science Education International, 17*(3), 187-203.

Zainordin, N., Wahi, W., Petrus, M., & Koh, C. T. (2017). Sustainable Development Attitude: A Study On Perception Among Private & Public Higher Learning Institutions Student In Malaysia. *MATTER: International Journal of Science and Technology, 3*(2), 514-524. https://doi.org/10.20319/mijst.2017.32.514524