

A New Situation Analysis in Environmental Literacy: Microplastic Waste Awareness

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Abstract

The aim of this study is to compare the microplastic awareness levels of pre-service teachers from different branches. The study was conducted with a general survey design, one of the quantitative research methods. The study group consisted of students enrolled in the teaching formation certificate program at Uşak University in the spring semester of 2025. The “Microplastic Awareness” test used in the study was developed by Sandalcı. It was determined that pre-service teachers' awareness of microplastics was at a low level. There was no significant difference between the microplastic awareness scores of pre-service teachers in the fields of science and health sciences. It was determined that there was a significant difference between the awareness scores of female pre-service teachers and the mean scores of male pre-service teachers in the dimension of the ways microplastics are found in nature. It was determined that there was a significant difference between the mean scores of pre-service science teachers and pre-service health sciences teachers in the dimension of the way microplastics are found in nature. In order to increase the awareness of pre-service teachers about microplastics, there should be a microplastics course in all associate and undergraduate programs at universities. Under awareness projects at universities; conferences, seminars, teleconferences, e-seminars, digital exhibitions and environmental trips can be organized to raise awareness on microplastics.

Keywords: Environmental literacy, microplastic waste, pre-service teachers, awareness.

Introduction

As a new approach, philosophy and competence area, environmental literacy encompasses different competencies. Environmental literacy aims to raise individuals with the attitudes, values, knowledge and skills necessary for environmental action (Mastrángelo, et al., 2019). Critical thinking and action-oriented decision-making at both individual and societal levels are becoming necessary for a sustainable environmental awareness. The ultimate goal of environmental literacy is to create a democratic society with individuals who actively participate in environmental situations (Carter & Simmons, 2010). Environmental literacy is defined as individuals' sensitivity, knowledge, skills, attitudes, responsibility and active participation in the environment (McBride, et al., 2013).

Environmental literacy has expanded over time to cover all human relations with the environment. An environmentally literate individual is someone who can predict how all social activities in nature will affect him/her and make environmental health sustainable (Orr, 1990). Environmental literacy emphasizes active citizenship that knows the effects of humans and the environment on each other, has a belief in change, and aims to change the negative situations that occur as a result of human-environment interaction (Roth, 1992). Environmental literacy includes three competence areas. These are basic environmental literacy, functional environmental literacy and operational environmental literacy. In basic environmental literacy, the individual has the competence to recognize and use basic concepts related to the environment. In functional environmental literacy, the individual has a broad knowledge of the interactions between ecosystems. In actional environmental literacy, the individual has the competence to protect and improve to environment (Altınöz, 2010). In this context, the basis of environmental literacy is based on individuals' awareness of the elements that threaten the environment. Environmental pollution is one of the main threats to environment.

Environmental Pollution

When examining environmental literacy, the most common threat is environmental pollution (Erkan, 2002). Environmental pollution includes all kinds of effects that will cause negative effects on the health of living things and nature. Environmental pollution is the mixing of foreign substances into water, soil and air, which have a negative impact on all physical elements of environment and adversely affect the lives of living things (Gündoğdu, et al., 2016). Environmental pollution, which occurs as a result of the deterioration of the physical and chemical balance of the world, negatively affects the health of humans and other living things. These negative factors leading to environmental problems are interrelated. For example, as air pollution increases, the accumulation of carbon dioxide in the atmosphere increases, leading to global warming. With global warming, glaciers melt and this leads to flooding of agricultural land (Keleş, et al., 2012). The main causes of environmental pollution



are rapid population growth, unconscious agricultural activities, lack of infrastructure in settlement centers, improper urbanization, irregular industrialization and widespread use of plastics (Yücel & Morgil, 1998). Environmental pollution includes water pollution, air pollution, soil pollution, noise pollution and radioactive pollution. Microplastics are among the factors that affect such pollution the most (Şimşir, 2024). Microplastics will be among the environmental problems that will occupy scientists the most in near future (Monroe, et al., 2008).

Microplastics

Microplastics are plastic particles, usually smaller than 5 millimeters in size, that are released into nature from various sources. These particles may be initially generated by the breakdown of large plastic waste, or they may be small plastic particles produced during industrial processes. Microplastics can cause environmental problems by spreading into waterways, seas and terrestrial ecosystems (Şimşir, 2024). The emergence of microplastics usually starts with the breakdown of large plastic waste under environmental conditions. Factors such as sunlight, oxidation, wave action and mechanical abrasion can cause large pieces of plastic to break into small pieces and form microplastics. Furthermore, the production, processing and use of plastic products during industrial activities can result in the release of microplastics into the environment. For example, microplastic particles used in cosmetic products can reach waterways and eventually seas through sewage systems (Merlino, et al., 2015).

Microplastics are divided into two groups: primary and secondary (Guirgis, et al., 2011). Primary microplastics are defined as specially produced particles. Pellets used as biofuel are an example of primary microplastics. Secondary microplastics include large plastic wastes composed of various components (SAPEA, 2019). Newly developed bio-based plastics (polylactide acid) and allegedly biodegradable plastics (oxo-degradable polyolefins) have a negative impact on microplastic pollution as they do not fully degrade under natural conditions. (Lambert & Wagner, 2017). Microplastics are composed of various polymers. The most common types of microplastic polymers found in nature are; PP (26.3%), PE (25%), PET/Polyester (8.8%), cellulose derived polymers (7.5%), poly (acrylic acid) (2.5%), PVC (1.3%), polyacrylonitrile (1.3%), poly (ethylene co-vinyl acetate) (1.3%), PA (1.3%), nylon-6 (1.3%) and acrylonitrile butadiene styrene (ABS) (1.3%) (Guirgis, et al., 2011).

Microplastics can be mixed directly into water, or they can be mixed into nature through textiles or cosmetic products (Yurtsever, 2015). The amount of plastics entering marine environments has reached a total of 12.2 million tons annually, including 9 million tons on land, 0.5 million tons in inland waters and 1.75 million tons in aquaculture (Jovanovic, et al., 2018; Schirinzi, et al., 2017). Of the 12.2 million tons of plastic detected, 94% is found on the seabed, with a rate of 70 kg/km². Microplastics can originate from vehicle waste, landslides, textiles, building paints, road paints, cosmetic paints and marine paints (Eunomia, 2016). Currents and waves provide horizontal transport of microplastics in aquatic systems, while

aquatic organisms living at different depths provide vertical transport (Hermsen, Mintenig, Besseling & Koelmans, 2018; Reisser, et al., 2015). Mussel, salmon and trout facilities established close to marine environments are considered among the most important causes of microplastic pollution in aquatic ecosystems. For example, research to identify the source of plastic waste on the beaches of southern Chile found that the most common plastic waste was Styrofoam (Hinojosa & Thiel, 2009). Sewerage systems are one of the different ways microplastics are spread (Carr, Liu & Tesoro, 2016; Talvitie, et al., 2015). In preventive studies, it was observed that microplastics decreased by 97% after the filtration process applied in sewers (Mintenig, et al., 2017). In the cosmetics industry, which is one of the other sources of microplastics, microbeads consisting of microplastics are often preferred in skin cleansing and care products (Beckwith & Fuentes, 2018; Juliano & Magrini, 2017). These microscopic microbeads enter water systems and cause spread of microplastics into aquatic ecosystems (Cole, et al., 2011). Another important source for microplastics is synthetic fabrics used in textile industry (Napper & Thompson, 2016). Synthetic fabrics are subjected to physical and chemical abrasion during washing and the synthetic fibers break down into smaller microfibers. Therefore, microfibers that can be mixed into water systems through the waste water pipes of washing machines cause microplastic pollution (Browne, et al., 2015). Research has shown that microplastics are spread over large areas of the earth's surface (Lebreton, et al., 2018).

Humans can be exposed to microplastics through airborne and skin contact. It is also possible to be exposed to microplastics directly through mouth via food and drinks. It is known that humans are exposed to large amounts of microplastics through the consumption of marine organisms. (Akçay, et al., 2020). Seafood threatens human health and poses a problem for food safety due to the microplastics they contain. (De-la-Torre, 2020). In another study, 20 different brands of sardines and canned food from 13 different countries in 4 different continents were examined and it was found that 4 canned food brands generally contained PP and PET microplastics. In different studies, microplastics have been found in tap water, ready-to-drink drinking water, canned drinks, mineral water, beer, seafood (such as fish and crustaceans), canned products, packaged products such as chicken, honey, sugar, table salt, sea salt, tea bags and rice (Karami, et al., 2018).

Problem Status

It has been reported that there are differences between awareness levels of countries regarding sources of microplastics (SAPEA, 2019). To reduce the environmental impact of microplastics, it is important to identify and control the sources of microplastics as well as plastic waste. This includes regulating use of microplastics in cosmetic products, reducing use of synthetic fibers in the textile industry and developing industrial wastewater treatment plants. It could also include raising public awareness of microplastic pollution and promoting recycling (Markaki,2017). In the literature, it has been determined that studies on environmental pollution caused by plastic waste and its damages to human health are

predominant (Gayford, 2002 ; Güler & Çobanoğlu, 1994 ; Brown et al., 1997 ; Ertürk, 2009 ; Özmen, et al. 2005 ; Karataş, 2019; Özgel, et al., 2018; Karakuş, 2018; Orhan, 2018; Uyanık, 2016; Özdemir Güloğlu, 2018; Demirkıran, 2015 ; Özcan, 2010 ; Kayalı, 2018).

Microplastic studies in the literature generally focus on the sources of microplastics and their effects on human and environmental health (Demir, et al., 2024 ; Balcı, 2020; Arı & Öğüt, 2021; Akçay, et al., 2020; Çağlayan & Aytan,2020; Kenan & Teksoy,2022; Payton, 2017; Tang, et al., 2018; Welle & Franz, 2018; Prata, et al., 2019; Watkins, et al., 2019; Ferreira, et al., 2019; Akarsu, et al., 2017; Schumacker & Lomax, 1996). The first important step to be taken against the proliferation of microplastics on the Earth's surface is to raise awareness about microplastics, starting with schools. Raising awareness in schools starts with raising awareness in pre-service teachers and teachers. Lectures and non-formal education activities on microplastics in universities will contribute to the awareness of pre-service teachers. In this context, the microplastic awareness levels of pre-service teachers were compared in this study. In the study, the data were tested in the context of the following questions;

- ✓ What is the level of microplastic awareness of pre-service teachers?
- ✓ Does microplastic awareness level of pre-service teachers show a significant difference according to the branch?
- ✓ Does microplastic awareness level of pre-service teachers show a significant difference according to gender?

METHOD

Study Pattern

The study was conducted with a general survey design, one of the quantitative research methods. The reason why this model is preferred is that it provides generalizable predictions obtained from a sample consisting of different groups and many people. Generalizations are made as a result of statistical analysis of the quantitative data obtained (Büyüköztürk, et al., 2022).

Study Group

The study group consisted of students enrolled in the teaching formation certificate program at Uşak University in the spring semester of 2025. The researchers distributed the microplastic awareness test to all 463 pre-service teachers simultaneously. A total of 250 tests were evaluated. Of the pre-service teachers in the study group, 132 were health sciences majors and 118 were science majors. The study group consisted of 146 female and 104 male.

Data Collection Tool

The “Microplastic Awareness” test used as a data collection tool was developed by Sandalcı (2021). The data collection tool is an awareness test consisting of a total of 24 questions. Correct answers to the test items were evaluated as 1 point, while incorrect answers and items left blank were evaluated as 0 points. The minimum score is 0 and the maximum score is 100. The distribution of the questions in the awareness test is as follows: the concept of microplastics 3 questions, the properties of microplastics 1 question, the way microplastics are found 3 questions, the sources of microplastics 1 question, the use of microplastics 4 questions, the types of microplastics 2 questions, product purchase 5 questions, plastic footprint 2 questions and prevention of microplastics 3 questions. It was made clear to the pre-service teachers that they could mark more than one option for each question. The Cronbach's Alpha reliability level of test was (.809 > .700) and it was determined that its reliability was high (Hair, et al., 1998; Hoyle, 1995; Hu & Bentler, 1999).

Data Analysis

In the study, the Kolmogorov - Smirnov test score was taken into consideration to determine whether the test scores showed a normal distribution. As a result of the test (.200, $p > .05$), it was determined that the data were normally distributed. In line with the sub-objectives of the study, independent groups t-test, one of the parametric tests, was deemed appropriate.

Limitations of the Study

The study group is limited to the test scores of pre-service teachers in the branches of science and health sciences who are expected to be aware of microplastics.

Results

In the findings section of the study, t-test scores of pre-service teachers' microplastic awareness scores, branch and gender variables are presented.

Table 1. Comparison of Prospective Teachers' Microplastic Awareness Scores According to Branch

	Branch	N	\bar{x}	SS	Upper Score Limit of the Test
Microplastic Awareness	Health Sciences	132	49.97	15.43	87.00
	Science	118	49.82	14.32	79.00
Microplastic Concept Awareness	Health Sciences	132	1.62	1.16	7.00



	Science	118	1.96	1.54	9.00
Microplastic Shapes Awareness	Health Sciences	132	1.92	2.04	9.00
	Science	118	2.64	2.37	9.00
Usage Area Awareness	Health Sciences	132	13.07	5.61	26.00
	Science	118	13.22	5.25	23.00
Microplastic Species Awareness	Health Sciences	132	4.67	2.78	10.00
	Science	118	4.59	2.61	10.00
Microplastic Footprint Awareness	Health Sciences	132	1.14	.957	7.00
	Science	118	1.09	.891	6.00
Microplastic Prevention Awareness	Health Sciences	132	6.07	2.27	8.00
	Science	118	5.84	2.15	8.00
Awareness of Microplastic Effects	Health Sciences	132	15.85	5.81	24.00
	Science	118	14.90	5.03	23.00
Awareness of Microplastic Characteristics	Health Sciences	132	2.26	1.12	5.00
	Science	118	2.27	1.23	5.00
Source Awareness of Microplastics	Health Sciences	132	2.90	1.39	5.00
	Science	118	2.67	1.33	5.00
Purchasing Awareness	Health Sciences	132	0.43	.589	2.00
	Science	118	0.50	.718	2.00

It was determined that the general microplastic awareness mean scores of pre-service teachers in the branches of science (\bar{x} : 49.82) and health sciences (\bar{x} : 49.92) in the study group were close to each other, but awareness was low. It was determined that pre-service teachers had low levels of awareness about the concept, shape, area of use, types, footprint, precautions, effects, sources and purchasing that constitute the dimensions of microplastics. Considering the effects of microplastics on the environment and human health, it is necessary to raise awareness among prospective teachers.

Table 2. Comparison of Microplastic Dimensions Awareness Levels of Prospective Teachers According to Branch (t test)

<i>Microplastic Awareness</i>	Branch	N	\bar{x}	SS	F	t	p
	Health Sciences	132	49.97	15.43	.057	.062	.951
	Science	118	49.82	14.32			
<i>Microplastic Concept Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	1.62	1.16	1.58	1.57	.118
	Science	118	1.96	1.54			
<i>Microplastic Shapes Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	1.92	2.04	2.56	2.06	.04*
	Science	118	2.64	2.30			
<i>Usage Area Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	13.07	5.61	.034	-.171	.865
	Science	118	13.22	5.25			
<i>Microplastic Species Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	4.67	2.78	.666	.171	.865
	Science	118	4.59	2.61			
<i>Microplastic Footprint Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	1.14	.95	.189	.377	.706
	Science	118	1.09	.89			
<i>Microplastic Prevention Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	6.07	2.27	.468	.652	.515
	Science	118	5.84	2.15			

<i>Awareness of Microplastic Effects</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	15.85	5.81	4.73	1.08	.278
Science	118	14.90	5.03				
<i>Awareness of Microplastic Characteristics</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	2.26	1.12	1.25	.024	.981
Science	118	2.27	1.23				
<i>Source Awareness of Microplastics</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	2.90	1.32	.385	1.07	.284
Science	118	2.67	1.33				
<i>Purchasing Awareness</i>		N	\bar{x}	SS	F	t	p
	Health Sciences	132	.43	.58	4.34	.649	.517
Science	118	.50	.71				

* $p < .05$

It was determined that there was no significant difference ($p > .05$) between microplastic awareness scores of pre-service science teachers (\bar{x} : 49.82) and microplastic awareness scores of pre-service health sciences teachers (\bar{x} : 49.92) according to branch.

It was determined that there was no significant difference ($p > .05$) between the mean scores of pre-service science teachers and pre-service health sciences teachers in the dimensions of microplastic concept, area of use, types, footprint, prevention, effects, sources and purchasing awareness.

It was determined that there was a significant difference ($p < .05$) between the mean scores of pre-service science teachers and pre-service health sciences teachers in the dimension of the way microplastics are found in nature. The mean awareness score of pre-service science teachers (\bar{x} : 2.64) about the ways microplastics are found in nature is higher than the mean score of pre-service health sciences teachers (\bar{x} : 1.92). It is seen that pre-service science teachers have higher awareness in the dimension of the way microplastics are found in nature. This may be attributed to the learning outcomes of pre-service science teachers in nature and laboratory courses.

Table 3. Comparison of Microplastic Awareness Levels of Prospective Teachers According to Gender (t test)

<i>Microplastic Awareness</i>	Gender	N	\bar{x}	SS	F	t	p
	Female	146	50.48	14.83	.009	.869	.386
Male	104	48.07	14.99				
<i>Microplastic Concept Awareness</i>		N	\bar{x}	SS	F	t	p
	Female	146	1.79	1.28	.637	.119	.906
Male	104	1.76	1.61				
<i>Microplastic Shapes Awareness</i>		N	\bar{x}	SS	F	t	p
	Female	146	2.55	2.31	5.84	.017	.005*
Male	104	1.39	1.70				
<i>Usage Area Awareness</i>		N	\bar{x}	SS	F	t	p
	Female	146	13.28	5.25	1.29	.256	.551
Male	104	12.68	6.00				
<i>Microplastic</i>		N	\bar{x}	SS	F	t	p



Species Awareness	Female	146	4.57	2.68	.045	.833	.638
	Male	104	4.81	2.75			
Microplastic Footprint Awareness		N	\bar{x}	SS	F	t	p
	Female	146	1.15	.877	.724	.396	.927
	Male	104	1.13	1.06			
Microplastic Prevention Awareness		N	\bar{x}	SS	F	t	p
	Female	146	6.04	2.18	.177	.674	.423
	Male	104	5.71	2.30			
Awareness of Microplastic Effects		N	\bar{x}	SS	F	t	p
	Female	146	15.40	5.40	.741	.391	.969
	Male	104	15.36	5.68			
Awareness of Microplastic Characteristics		N	\bar{x}	SS	F	t	p
	Female	146	2.31	1.21	.079	.779	.405
	Male	104	2.13	1.27			
Source Awareness of Microplastics		N	\bar{x}	SS	F	t	p
	Female	132	2.81	1.27	3.70	.056	.665
	Male	118	2.71	1.52			
Purchasing Awareness		N	\bar{x}	SS	F	t	p
	Female	132	0.50	.647	.502	.480	.266
	Male	118	0.36	.674			

* $p < .05$

While the microplastic awareness scores of female pre-service teachers were at the level of (\bar{x} : 50.48), the microplastic awareness scores of male pre-service teachers were at the level of (\bar{x} : 48.07). It was determined that female pre-service teachers had higher microplastic awareness than male pre-service teachers, but the difference was not significant ($p > .05$).

It was determined that there was no significant difference ($p > .05$) between the mean scores of female pre-service teachers and male pre-service teachers in the dimensions of microplastic concept, area of use, types, footprint, prevention, effects, sources and purchasing awareness.

It was determined that there was a significant difference ($p < .05$) between the awareness scores of female pre-service teachers (\bar{x} : 2.55) and the mean scores of male pre-service teachers (\bar{x} : 1.39) in the dimension of the ways microplastics are found in nature. In the dimension of the ways microplastics are found in nature, it was determined that the awareness level of female pre-service teachers was higher than that of male pre-service teachers.

Conclusion and Discussion

It was determined that the overall mean microplastic awareness score of pre-service teachers in science and health sciences branches was quite far from the upper score limit of the test. When compared with other studies in the literature, it is seen that these findings are consistent, as follows: Şimşir (2024) found that university students' awareness of microplastic wastes was not at an adequate level. In his study, Demirkıran (2015) determined that the awareness of pre-service science teachers and pre-service primary school teachers about

microplastic wastes was at a medium level. Sandalcı (2021) determined that the awareness level of pre-service science teachers on “Microplastics” was at a low level. Güleşir (2021) determined in his thesis study that pre-service science and biology teachers' awareness of microplastic pollution is low. Kaya (2022) found that pre-service science teachers' attitudes towards microplastics within the scope of environmental problems were at a low level.

There is no significant difference between the general microplastic awareness scores of pre-service science and health sciences teachers according to branch. When compared with other studies in the literature, it is seen that the findings are consistent with each other, as follows: In different studies, it was determined that microplastic awareness of pre-service teachers did not show a significant difference according to branch (Kocakurt & Güven, 2005 ; Aminrad, et al., 2011; Şimşir, 2024). In contrast to these findings, Davarah, et al. (2022), in a study conducted in India, found that microplastic awareness of university students showed a significant difference according to their major. Here, the fact that students in the field of science have higher microplastic awareness than students in the field of social sciences can be considered as an expected situation in the context of learning outcomes.

It was determined that the difference between the microplastic awareness scores of female pre-service teachers in the study group and the microplastic awareness scores of male pre-service teachers was not significant ($p > .05$). In different studies on microplastics, it was determined that there was no significant difference between the awareness levels of girls and boys. (Chmielewski, et al., 2022 ; Oleksiuk, et al., 2022).

As a result, it was determined that pre-service teachers' microplastic awareness levels were low. In order to increase the awareness of pre-service teachers about microplastics, there should be a microplastics course in all associate and undergraduate programs at universities. Microplastic literacy certificate trainings should be provided by lifelong learning centers of universities. Under awareness projects at universities; conferences, seminars, teleconferences, e-seminars, digital exhibitions and environmental trips can be organized to raise awareness on microplastics.

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