

THE EFFECT OF THE BARRIER-FREE NATURE, BARRIER-FREE SCIENCE EDUCATIONAL PROGRAMME ON THE ENVIRONMENTAL LITERACY LEVELS OF HEARING-IMPAIRED STUDENTS

O EFEITO DO PROGRAMA EDUCACIONAL "NATUREZA SEM BARREIRAS, CIÊNCIA SEM BARREIRAS" NOS NÍVEIS DE ALFABETIZAÇÃO AMBIENTAL DE ALUNOS COM DEFICIÊNCIA AUDITIVA

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Abstract

This study aims to examine how an educational programme, which is designed to improve the creativity and learning skill levels of hearing-impaired children and partly conducted outdoors, affects their environmental literacy levels. This study was conducted using quasi-experimental design, one of the quantitative research designs. The study group consists of a total of 40 students diagnosed with hearing-impairment (20 students in the experimental group and 20 students in the control group) who were attending grades 5, 6, and 7 in formal education institutions in the central districts of Kayseri province and voluntarily participated in the project under the project criteria. The independent variable of the study was the educational programme, while the dependent variable was the environmental literacy levels of the hearing-impaired students. An educational programme that supports creativity and focuses on science for hearing-impaired children was prepared and implemented under the project, "Barrier-Free Nature, Barrier-Free Science," with the ID No. 658976, executed by Kocasinan District Directorate of National Education and supported within the scope of TÜBİTAK 4008 - Inclusive Science and Social Practices Support Programme for Individuals with Special Needs. The data was collected using the Environmental Affect Scale. The resulting data set was analysed using the Mann-Whitney U test and the Wilcoxon Signed-Rank Test. Based on the findings, it was found

Resumo

Este estudo tem como objetivo examinar como um programa educacional, concebido para melhorar a criatividade e as habilidades de aprendizagem de crianças com deficiência auditiva e realizado parcialmente ao ar livre, afeta seus níveis de alfabetização ambiental. Este estudo foi conduzido utilizando um delineamento quase-experimental, um dos métodos de pesquisa quantitativa. O grupo de estudo é composto por um total de 40 alunos diagnosticados com deficiência auditiva (20 alunos no grupo experimental e 20 alunos no grupo de controle) que cursavam o 5º, 6º e 7º ano do ensino fundamental em instituições de ensino formal nos distritos centrais da província de Kayseri e participaram voluntariamente do projeto, de acordo com os critérios estabelecidos. A variável independente do estudo foi o programa educacional, enquanto a variável dependente foram os níveis de alfabetização ambiental dos alunos com deficiência auditiva. Um programa educacional que promove a criatividade e se concentra em ciências para crianças com deficiência auditiva foi elaborado e implementado no âmbito do projeto "Natureza Sem Barreiras, Ciência Sem Barreiras", com o número de identificação 658976, executado pela Diretoria Distrital de Educação Nacional de Kocasinan e apoiado pelo programa TÜBİTAK 4008 - Programa de Apoio à Ciência Inclusiva e Práticas Sociais para Pessoas com Necessidades Especiais. Os



that the hearing-impaired students who attended the Barrier-Free Nature, Barrier-Free Science Educational Programme had significantly higher scores on environmental affect scale compared to those who did not, and this rise was permanent.

Keywords: Hearing Impaired. Environmental Awareness. Environmental Literacy. Project. Barrier-Free Science.

dados foram coletados utilizando a Escala de Afeto Ambiental. O conjunto de dados resultante foi analisado por meio do teste U de Mann-Whitney e do teste de Wilcoxon para postos sinalizados. Com base nos resultados, constatou-se que os alunos com deficiência auditiva que participaram do programa educacional “Natureza Sem Barreiras, Ciência Sem Barreiras” obtiveram pontuações significativamente mais altas na escala de afeto ambiental em comparação com aqueles que não participaram, e esse aumento foi permanente.

Palavras-chave: Deficiência Auditiva. Consciência Ambiental. Alfabetização Ambiental. Projeto. Ciência sem Barreiras.

1 INTRODUCTION

The problems people with disabilities face in education are widespread internationally. We begin learning from the minute we are born, and our learning happens experientially through our senses. However, the educational process for people with physical disabilities may progress in a more limited and different manner compared to those without any disabilities. The proper acquisition of knowledge depends on the coordinated functioning of multiple sensory organs. One of these sensory organs is the normal auditory system. Hearing impairment affects the acquisition of oral language. During school, teachers usually teach information to students through oral instruction.

“Hearing loss” refers to the inability of the ear to hear sufficiently and is diagnosed according to its degree, type, and the age at which it occurs. To describe individuals as hearing impaired, they must have a full or partial loss of hearing in their hearing organ. If a person is unable to hear sound at any frequency, they are considered to have a ‘hearing impairment.’ Quinsland (1993) described hearing loss as an inability to perceive acoustic data related to speech and environmental sounds. Hearing loss is a major problem and one of the greatest barriers to communication, education, and social integration, leading to a lack of communication. It can be asserted that hearing-impaired individuals face greater challenges than individuals with other disabilities, particularly in academic education. Studies in the literature have indicated that hearing-impaired individuals require more stimuli in their education and the environmental arrangements to provide these stimuli (Kayhan et al., 2015; Piştav Akmeşe, 2018). One of the problems that

hearing-impaired children go through is isolation from their social environment. This means that they are unable to find their place in society and are isolated by others (Thomas et al., 1989). Most of human behaviours are learned behaviours. People learn new things in society through the process of socialisation. On the other hand, an individual's social competence changes depending on whether they hear normally or have a hearing impairment. In the perception of social support, the following are considered important: participation in school, classroom, and social activities, as well as feeling emotionally secure with hearing friends (Temel et al., 1998).

Environmental literacy refers to the degree to which an individual is sensitive to the environment and environmental issues, as well as the ability to pay attention to the structure of society when making decisions about the environment and behaving environmentally responsible (Roth, 1968). While the environment (nature, outdoors) is of great importance to all living beings, significant destruction is inflicted upon it with each passing day. Distinguished from other living creatures by the ability to think and speak, humans emerge as one of the main actors responsible for this extensive damage. Throughout history, the environment has always held importance for humankind—both influencing humans and being influenced by them—and, accordingly, humans have also struggled to protect it (Pooley & O'Connor, 2000). Environmental educational practices that train environmentally conscious and aware human resources hold an important place in solving environmental problems that threaten human life (Özdemir, 2007). Uzun and Sağlam (2006) highlight the importance of educational activities in approaches to finding permanent solutions to environmental problems, stating, “Raising individuals who are aware and sensitive to environmental matters appears to be the most effective way to solve these problems.” Environmental education or awareness refers to a multidimensional process involving cognitive, affective, and behavioural aspects.

Under the TÜBİTAK 4008 - Inclusive Science and Social Practices Support Programme for Individuals with Special Needs, an educational programme that supports creativity and focuses on science for hearing-impaired children was prepared within the scope of the project, “Barrier-Free Nature, Barrier-Free Science,” by the Kocasinan District Directorate of National Education. This study generally aims to examine the effect of an educational programme designed to improve the creativity and learning skill levels of hearing-impaired children on their environmental literacy levels.

The following hypotheses were tested based on this general objective:

Hypothesis 1) The *posttest* subscale and total mean scores of the hearing-impaired students in the *experimental* group who attended the Barrier-Free Nature, Barrier-Free Science Educational Programme on the Environmental Affect Scale are significantly higher than their *pretest* mean scores.

Hypothesis 2) No significant difference is found between the *posttest* mean scores and *pretest* mean scores of the hearing-impaired students in the *control* group who did not attend the Barrier-Free Nature, Barrier-Free Science Educational Programme on the Environmental Affect Scale.

Hypothesis 3) The *follow-up test* mean scores of hearing-impaired students in the *experimental* group on the Environmental Affect Scale are significantly higher than their *pretest* mean scores (the change is permanent).

2 METHOD

2.1 Research model

The quasi-experimental model with pretest, posttest, and follow-up test assessments and control group, frequently used in the social sciences was used in this study. This model shows the first factor as the experimental procedure groups (experimental-control) and the second factor as the repeated assessments related to the dependent variable (pretest-posttest-follow-up test) (Büyüköztürk et al., 2024). This study aims to test the effect of the Barrier-Free Nature, Barrier-Free Science Educational Programme on the environmental literacy levels of hearing-impaired students.

The independent variable of the study was the educational programme provided to the experimental group between the pretest and posttest. The dependent variable was the environmental literacy levels of hearing-impaired students.

Table 1 shows the research design.

Table 1*Research Design:*

Groups	Pretest	Procedure	Posttest	Follow-Up Test
Experimental	<i>Assessment I</i> Environmental Affect Scale	9 Days Science-Focused Educational Programme	<i>Assessment II</i> Environmental Affect Scale	<i>Assessment III</i> Environmental Affect Scale
Control	<i>Assessment I</i> Environmental Affect Scale	-	<i>Assessment II</i> Environmental Affect Scale	

2.2 Study group

Due to the project, 97 hearing-impaired students attending the 5th, 6th, and 7th grades in formal educational institutions in Kocasinan, Melikgazi, and Talas, the central districts of Kayseri province, were included in the study. The study group consisted of a total of 40 hearing-impaired students (20 in the experimental group and 20 in the control group), who volunteered to participate in the project according to the project criteria.

While forming the study group, the Form for Identifying Hearing-Impaired Students created by the Kocasinan District Directorate of National Education was sent to all state and private schools in three districts through DMS, the official correspondence system of the Ministry of National Education, and each of the schools was asked to fill out the form, and 97 students diagnosed with hearing impairment were identified. The Kocasinan District Directorate of National Education, where the project coordinator is employed, sent an official letter via the Document Management System (in electronic media) to schools regarding students diagnosed with hearing impairment and these students were identified to participate in the study on a voluntary basis through their school principals. Moreover, since the students were under the age of 18, their parents were asked to provide a letter of consent and medical reports. Firstly, the students were ranked from the highest to the lowest disability rate among the students who met the application conditions and were registered. Furthermore, since no second disability was present, the students were selected from those who could participate in the project without the need for a guardian. They were also selected from students with the highest school success average among those with equal conditions. Besides the criteria set out for the selection of the study group, a homogeneous experimental group of 20 students and a

homogeneous control group of 20 students who did not want to participate in the training were formed by considering the gender distribution and grade levels of the students.

2.3 Data collection tools and data collection

The Environmental Affect Scale was used to assess the dependent variable of this study. Sontay, Gökdere, and Usta (2015) developed the “Environmental Knowledge Test, Environmental Affect Scale, Environmental Behaviour Scale, and Cognitive Skill Interview Form,” which includes components of environmental literacy relevant to the environmental gains in the science and technology lessons for secondary school students in 6th, 7th, and 8th grades. The educational programme prepared for the experimental implementation in this study is a science-based educational programme and overlaps with the theoretical basis on which the scale was developed.

Environmental Affect Scale (EAS): The scale was developed by Sontay, Gökdere, and Usta (2015) to determine the affective dispositions of secondary school students towards the environment. This 5-point Likert-type scale consists of 15 items and three subscales. Students are expected to mark the extent to which they agree with the written statements. Environmental responsibility subscale includes items 1, 9, 10, 13, and 14; environmental sensitivity subscale includes items 2, 6, 7, 11, and 15; and environmental perception subscale includes items 3, 4, 5, 8, and 12. Since the subscales are positive, the higher total score indicates a higher level of environmental literacy. In their study, Sontay, Gökdere, and Usta (2015) examined the face validity, content validity, and construct validity of the scale for its validity scale. Expert opinion was taken for face and content validity, and exploratory factor analysis was run for construct validity. In the validity study of the scale, they calculated Cronbach’s Alpha reliability coefficient as .86 for the overall scale and .86, .80, and .78 for its subscales.

2.4 Content of the educational programme

For the practice, an educational programme that supports creativity and focuses on science for hearing-impaired children was prepared under the project, “Barrier-Free Nature, Barrier-Free Science” with the ID No. 658976. While preparing the programme, special attention was paid to make sure that the programme consisted of visual, practical,

and structured activities due to the physical, psychological, and emotional characteristics of hearing-impaired students. The content of the educational programme was prepared by taking expert opinions from three academicians who are experts in science, one in psychological counselling and guidance, one in special education, and two academicians who are not involved in the project. The programme was delivered continuously for six hours a day for nine days. The following studies were conducted during the preparation of the training programme in order to achieve the project's aim.

- Hearing-impaired students, their families, and teachers were interviewed, and their general wishes and expectations were identified.
- Expert opinion was sought from a special educational specialist about the students and the training programme.
- While creating the content, literature was reviewed extensively, and reference books and research results were considered and utilised while identifying the session topics. An original programme was created by interpreting, assimilating, and integrating the information gathered from domestic and foreign sources. A programme of 29 topics of training and activities was held, including “Let’s Build a Model Aircraft, Launch a Rocket,” “I Am Aware of Climate Change! I Am Also Here To Fight Against Climate Change!”, “Biodiversity in Sultan Reeds,” “Microscopic Life in Water,” “Art in Nature,” “Visit to SpaceBIMER and Solar Observation,” “GENKÖK Technical Trip,” “Journey to UNESCO with Mimar Sinan,” “Little Archaeologists at Work,” “Wearable Electronics,” and “I Meet Orienteering,” etc.

2.5 Data analysis

The research included two different groups: the experimental group, to which the educational programme was applied, and the control group, to which no procedure was followed. Since the study is an experimental trial with small number of subjects, the Mann-Whitney U test and the Wilcoxon signed-rank test for unrelated assessments were run to test the statistical significance of pretest and posttest assessments (Köklü, Büyükoztürk, & Çokluk, 2024). The Mann-Whitney U test is run to test whether the means of two or more unrelated samples significantly differ from each other. The

Wilcoxon Signed-Rank Test analyses whether or not the means differ significantly in related samples (Köklü, Büyüköztürk, & Çokluk, 2024).

The study group consisted of 40 students including 20 students in experimental group (11 female, 9 male) and 20 students in control group (10 female, 10 male). When analysing the data, .05 was considered as the significance level.

Data analysis was first examined to determine whether or not there was a significant difference in the groups at the beginning of the experimental procedure, for which effectiveness was studied, according to the analysed variable. In other words, the pretest results of the experimental and control groups were compared. Considering the number of students in the groups and the non-normal distribution ($p < .05$) of the scores of the students on the Environmental Affect Scale, the Mann-Whitney U test was run to determine the significance of the difference between the groups.

Before testing the hypotheses of the study, the assumptions that need to be verified in order to analyse correctly were tested. The hypotheses of the study were established based on analysing the significance of the means for related and unrelated groups. Thus, the data of the experimental and control groups were checked to determine whether or not they were normally distributed for the relevant analyses, but they were not normally distributed ($p < .05$). Therefore, all hypotheses were tested with non-parametric statistical tests.

The Wilcoxon Signed-Rank Test was run for the hypotheses. This is attributed to the basis of the stated hypotheses on the significance of the difference between different assessments from the same group (Köklü, Büyüköztürk & Çokluk, 2024). Significance level was accepted as 0.05 in the data analysis.

3 FINDINGS

The findings and comments from the statistical analyses to determine the effect of the educational programme applied to improve scientific creativity and learning on the environmental literacy levels of the students are listed in the order in which the hypotheses were written.

Table 2 presents the descriptive statistics of the scores of the students in the experimental and control groups on the Environmental Affect Scale.

Table 2

Descriptive Statistics Related to the Total and Subscale Scores of the Experimental and Control Groups on the Environmental Affect Scale

Group	Scale and subscales	Pretest		Posttest		Follow-Up Test	
		\bar{X}	S	\bar{X}	S	\bar{X}	S
Experimental (n= 20)	EAS Total Score	6.90	.52	17.50	.51	17.50	.51
	Envr. Responsibility	6.20	.48	10.30	.55	11.10	.56
	Envr. Sensitivity	7.30	.54	19.50	.56	19.00	.55
	Envr. Perception	7.15	.53	22.60	.58	22.30	.58
Control (n= 20)	EAS Total Score	7.20	.53	7.17	.53		
	Envr. Responsibility	7.00	.53	7.10	.52		
	Envr. Sensitivity	6.60	.50	6.40	.50		
	Envr. Perception	8.10	.56	8.00	.55		

The EAS total mean score was 6.90, mean score of the environmental responsibility subscale was 6.20, mean score of the environmental sensitivity subscale was 7.30, and mean score of the environmental perception subscale was 7.15 before the educational programme among the students who attended the programme. Their EAS total mean score was 17.50, their mean score on the environmental responsibility subscale was 10.30, their mean score on the environmental sensitivity subscale was 19.50, and their mean score on the environmental perception subscale was 22.60 after the educational programme. Their total mean score was 17.50, their mean score of environmental responsibility subscale was 11.10, their mean score of environmental sensitivity subscale was 19.00 and their mean score of environmental perception subscale was 22.30 in the follow-up test made after 60 days. On the other hand, the EAS total mean score of the students in the control group who did not attend the educational programme was 7.20, their mean score on the environmental responsibility subscale was 7.00, their mean score on the environmental sensitivity subscale was 6.60, and their mean score on the environmental perception subscale was 8.10 before the educational programme. Their EAS total mean score was 7.17, their mean score on the environmental responsibility subscale was 7.10, their mean score on the environmental sensitivity subscale was 6.40, and their mean score on the environmental perception subscale was 8.00 after the educational programme. Their total mean score was 7.30, their mean score of environmental responsibility subscale was 7.20, their mean score of environmental sensitivity subscale was 6.80, and their mean score of environmental perception subscale was 7.90 in the follow-up test made after 60 days (Table 2).

In the data analysis, firstly no significant difference was found in the groups at the beginning of the experimental procedure, for which effectiveness was studied, in terms of the analysed variable. In other words, the pretest results of the experimental and control groups were compared. Considering the number of students in the groups and the non-normal distribution ($p < .05$) of the EAS scores of the students, the Mann-Whitney U test was run to determine the significance of the difference between the groups, and the results are present in Table 3.

Table 3

Results of the Mann-Whitney U-Test for the Pretest EAS Scores of the Experimental and Control Groups

Group	Scale and subscales	N	Mean Rank	Rank Sum	U	p
Experimental (n=20)	EAS Total Score	20	18.26	294.60	150.40	0.88
	Envr. Responsibility	20	17.15	280.50	148.20	0.87
	Envr. Sensitivity	20	16.20	270.40	140.30	0.86
	Envr. Perception	20	18.00	290.20	149.00	0.89
Control (n=20)	EAS Total Score	20	18.74	300.10		
	Envr. Responsibility	20	17.00	278.00		
	Envr. Sensitivity	20	16.80	266.30		
	Envr. Perception	20	17.90	288.60		

No significant difference was found between the EAS total and subscale scores of the students in the experimental and control groups. This shows that the EAS scores of the experimental and control groups can be considered statistically equal ($U = 150.40, 148.20, 140.30, 149.00; p > 0.05$) (Table 3).

Table 4 shows the results of the Wilcoxon Signed-Rank Test run for testing **Hypothesis 1**.

Table 4

Results of the Wilcoxon Signed-Rank Test for the Posttest and Pretest EAS Scores of the Experimental Group

	Posttest - Pretest	n	Mean Rank	Rank Sum	z	p
Total Score	Negative Rank	0	0	0		
	Positive Rank	20	13	158.00	4.56*	0.00
	Equal	0	0			
Responsibility	Negative Rank	4	10	124.00		
	Positive Rank	14	12	126.00	2.43	0.72
	Equal	2	8	112.00		

Sensitivity	Negative Rank	0	0	0	5.11*	0.00
	Positive Rank	20	11	139.00		
	Equal	0	0			
Perception	Negative Rank	0	0	0	4.88*	0.00
	Positive Rank	20	10	128.00		
	Equal	0	0			

*Based on positive ranks

According to Table 4, there was a significant difference between the pretest and posttest total and subscale scores of the experimental group except for the environmental responsibility subscale ($z=4.56, 5.11, 4.88; p<.001$). No significant difference was found in the environmental responsibility subscale of the scale. When the rank means and sums of the difference scores were taken into consideration, the significant difference appeared to be in favour of the positive ranks. In other words, it could be asserted that the difference was in favour of the posttest scores of the experimental group. Thus, hypothesis 1 is confirmed, and it could be asserted that the applied educational programme raised the environmental literacy of the students.

Table 5 shows the results of the Wilcoxon Signed-Rank Test run for testing **Hypothesis 2**.

Table 5

Results of the Wilcoxon Signed-Rank Test for the Pretest and Posttest EAS Scores of the Control Group

	Posttest - Pretest	n	Mean Rank	Rank Sum	z	p
Total Score	Negative Rank	8	10	145.05	0.87	0.78
	Positive Rank	9	13	168.00		
	Equal	3	6	111.20		
Responsibility	Negative Rank	4	8	160.00	0.91	0.72
	Positive Rank	9	13	226.70		
	Equal	7	10	200.10		
Sensitivity	Negative Rank	5	6	159.20	0.78	0.80
	Positive Rank	6	8	186.00		
	Equal	9	14	198.12		
Perception	Negative Rank	4	0	168.00	0.56	0.58
	Positive Rank	6	10	198.00		
	Equal	10	15	220.02		

According to Table 5, there was no significant difference between the pretest and posttest total and subscale scores of the control group ($z=0.78, 0.72, 0.80, 0.58, p>0.05$). Thus, in this case, hypothesis 2 is confirmed. The finding indicated that there was no statistically significant difference between the pretest and posttest scores of the control group for environmental affect.

Table 6 shows the results of the Wilcoxon Signed-Rank Test run for testing **Hypothesis 3**.

Table 6

Results of the Wilcoxon Signed-Rank Test for the Pretest and Follow-Up Test Scores of the Experimental Group

Pretest-Follow-Up Test		n	Mean Rank	Rank Sum	z	p
Total Score	Negative Rank	0	0	0	5.87*	0.00
	Positive Rank	19	20	280.20		
	Equal	1	8	110.10		
Responsibility	Negative Rank	0	0	0	4.19*	0.00
	Positive Rank	18	9	246.40		
	Equal	2	8	190.10		
Sensitivity	Negative Rank	0	0	0	7.18*	0.00
	Positive Rank	9	22	270.50		
	Equal	3	14	210.12		
Perception	Negative Rank	0	0	0	3.56*	0.00
	Positive Rank	16	18	268.00		
	Equal	4	10	212.06		

*Based on positive ranks

According to Table 6, there was a significant difference between the pretest and follow-up test scores of the experimental group ($z=5.87, 4.19, 7.18, 3.56, p<.001$). When the rank means and sums of the difference scores were considered, the significant difference was observed to be in favour of the positive ranks. In other words, it could be asserted that the difference was in favour of the posttest scores of the experimental group. In this case, hypothesis 4 is confirmed, and it could be asserted that the level of environmental literacy elevated between the pretest and the follow-up test in the experimental group, indicating that the training was permanent.

4 DISCUSSION AND CONCLUSION

This study examined the effectiveness of the educational programme, “Barrier-Free Nature, Barrier-Free Science,” prepared for hearing-impaired students under the project with the ID No. 658976, supported within the scope of TÜBİTAK 4008 - Inclusive Science and Social Practices Support Programme for Individuals with Special Needs, and whether this effect was permanent or not. The results of the study indicated that the EAS scores of hearing-impaired students who attended the educational programme “Barrier-Free Nature, Barrier-Free Science” were significantly higher than those who did not

attend this educational programme, and this effect was permanent. This result proves that the aim of the study was supported and the hypotheses of the study were confirmed.

The fact that the education was provided in nature, in the laboratory, by experts in their fields, based on a lot of observation, oriented to practice for nine days continuously and intensively facilitated the learning of the students and provided them with an effective and intensive education. The high number of predictors of creativity caused the content of the programme to be full, and the physical and psychological characteristics of the hearing-impaired students caused the training time to be long during the day.

The results from the statistical analyses of the data collected during different time periods of the study showed that the following hypotheses were confirmed: The first hypothesis of the study: “The *posttest* mean scores of the hearing-impaired students in the *experimental* group, who attended the Educational Programme “Barrier-Free Nature, Barrier-Free Science”, on the Environmental Affect Scale are significantly higher than their *pretest* mean scores”, the second hypothesis of the study: “No significant difference was found between the *posttest* mean scores and *pretest* mean scores of the hearing-impaired students in the *control* group, who did not attend the Educational Programme, “Barrier-Free Nature Barrier-Free Science”, on the Environmental Affect Scale.”, the third hypothesis of the study, “The *follow-up test* mean scores of hearing-impaired students in the *experimental* group on the Environmental Affect Scale are significantly higher than their *pretest* mean scores (the change is permanent),”. The results of the study showed that there was a significant improvement in the environmental literacy of the hearing-impaired people who attended the Educational Programme “Barrier-Free Nature, Barrier-Free Science” in the posttest assessments at the end of the educational programme compared to their pretest assessments, and this improvement was permanent.

When the result of the study was evaluated together with the findings of previous related studies, most of studies support this result (Almeida & Fleer, 2021; Aslantaş, 2022; Babaoğlu, 2023; Balım, 2023; Baltabıyık, 2019; Bebek, 2021; Blackley & Howell, 2015; Çakır & Tüzün, 2024; Çermik, 2022; Choi & Lee, 2017; Doğru 2020; Filiz, 2013; Gülap, 2020; Güler, 2024; Gündüz Bahadır & Özay Köse, 2021; Kadayıfçı, 2008; Karatepe, 2023; Kovách, et al., 2021; Külegel, 2020; Lin et al., 2003; Nilada, Payougkiattikun & Thongsuk, 2024; Onuk, 2022; Paulus, 2000; Saçar, 2019; Schild, 2016; Sweeney, 2020; Tuncel, 2022; Ünal Çoban, 2009; Yavuz 2020; Yıldırım, 2022).

A study conducted by Iversen and Jonsdottir (2018) with six secondary school students, to investigate the factors promoting environmental citizenship in science education and to contribute to the development of the concept of environmental citizenship practice, reported that socio-scientific issues in real-life settings were important for understanding environmental citizenship. The study by Iversen and Jonsdottir (2018) is compatible with the present study. The psychoeducation prepared for the present study and applied to hearing-impaired children

Includes activities from real life. During the psychoeducation, the children learned by doing and experiencing.

Helvacı and Helvacı (2019) provided environmental education with ESTEM to 18 secondary school students in the 6th grade. They concluded that E-STEM activities caused a positive change in students' attitudes towards the environment and their perception of recycling. The present study revealed that the educational programme positively affected children's environmental sensitivities. In both studies, the education was provided to students in the secondary school period, where development takes place rapidly, and thus, the students were able to make more use of the educational programme, and their environmental literacy levels elevated.

The master's thesis of Küleğel (2020) examined the effect of E-STEM-based activities on the perceptions of gifted students towards the environment and their 21st-century skills. The study group of the research consisted of 17 gifted students in the 5th and 6th grades who attended BİLSEM. The study was implemented for 6 weeks and 34 hours in total. As a result of the study, it was observed that E-STEM practices had a positive effect on the improvement of gifted students' environmental perceptions and their 21st-century skills. The content and results of the training prepared and implemented within the scope of the project were compatible with the research results of Küleğel (2020). The education in both studies was effective in raising the environmental sensitivities of the students in the experimental group. In both studies, the environmental sensitivity of students improved as they were educated.

A study conducted by Almeida and Fleer (2021) with children from families of European, Iranian, Indian, Nepalese, and Taiwanese origin who immigrated to Australia indicated that the students established the link between the concepts of science and sustainability in their lives more easily after the E-STEM activities. The conceptualisation of E-STEM for protecting the environment was tried within the framework of the study

results. In the present study, an educational programme was prepared and implemented to raise environmental awareness.

The doctoral dissertation of Çermik (2022) reported that there was a significant difference in favour of the students in the experimental group on environmental citizenship knowledge, attitude, and responsible behaviour levels according to the quantitative results of the environmental citizenship education held with 37 secondary school students in the 7th grade using the research-inquiry method. The results of that study and the present study are similar. The education in both studies was effective in raising the environmental literacy levels of the students in the experimental group.

Based on the results of the study, recommendations for practitioners and researchers who will research environmental literacy and students with disabilities in the future are listed.

- ✓ The findings of the study indicated that the educational programme, “Barrier-Free Nature, Barrier-Free Science,” was effective in raising the environmental literacy levels of hearing-impaired students. This programme can be expanded and implemented in the schools run by the Ministry of National Education and special education and rehabilitation centres.
- ✓ During the education of preservice science teachers in faculties of education, the activities and practices covered in the educational programme should be utilised.
- ✓ The Barrier-Free Nature, Barrier-Free Science Programme should be implemented by making necessary adaptations and including the parents, teachers, and siblings of the students in the study.
- ✓ Educational programmes should be prepared for hearing-impaired students to improve their other skills (problem solving, social-emotional learning, high-level learning, communicating, building friendship, etc.) and tested to see whether or not they can contribute indirectly to their environmental literacy and their effects.
- ✓ Necessary adaptations to the Barrier-Free Nature Barrier-Free Science Programme should be made, and research designs should be created in which parents, siblings, and teachers of hearing-impaired students will participate together.
- ✓ Barrier-Free Nature, Barrier-Free Science Programme was prepared and implemented for the hearing impaired; the study group should be formed from other disability groups, and the research should be repeated.

- ✓ The number of descriptive and experimental studies on environmental literacy and environmental literacy among students with disabilities is limited in Türkiye. Studies that will contribute to the literature on the environment should be conducted with students from different age groups in different designs by using predictive and structural equation models.

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Authors' Contribution

Both authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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