Empowering Gifted Students as Environmental Change Agents: A Transformational Education Model

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Abstract: According to Sternberg (2020), transformational giftedness is the ability to enact enduring, significant, and constructive societal change. Gifted individuals can substantially influence environmental and sustainability issues, which are increasingly critical. Current study examined the practices of 9th-grade gifted students and their teachers to increase environmental awareness in 5th and 6th-grade gifted students. Drawing on Sternberg's concept of "other transformational giftedness," the research emphasizes high school students leading initiatives to improve younger students' understanding of environmental challenges. A simultaneous nested mixed methods research model was adopted in the current study. In the eight-week study, environmental education activities planned by talented high school students, educators, and experts were implemented. Gifted students raised awareness among their peers about the greenhouse effect, the causes of global warming, and environmental pollution. Both qualitative and quantitative data confirmed the program's success in boosting environmental consciousness through peer-led efforts. The model highlights interdisciplinary, interactive methods to foster transformational giftedness and address global issues.

Keyword: Transformational Giftedness in Environmental Education

Introduction

Long-term studies on giftedness reveal varying definitions. Terman (1916; 1925) defined giftedness as an IQ above 140 on the Binet test. As IQ alone proved insufficient, Renzulli (1978) introduced interacting traits: above-average abilities, motivation, and creativity. The Marland report (1972) associated giftedness with abilities in academics, creativity, leadership, arts, and psychomotor skills. Gardner (2011) highlighted multiple intelligences, including linguistic, musical, mathematical, and bodily-kinesthetic. Gagné (2010) defined giftedness as exceptional natural abilities placing individuals in the top 10% of their age group. Sternberg's Triarchic Theory underscored creative, analytical, and practical intelligence (Sternberg, 1999). Sternberg (2020; 2021) distinguished between transactional giftedness, driven by rewards and personal gain, and transformational giftedness, focused on creating meaningful societal change through innovation and selflessness. Although some academic studies have presented ideas about transformational giftedness, practical studies need to be conducted on this subject (Sternberg, 2024). Empirical studies are needed in this area to align the education of gifted individuals with the trends and problems of the 21st century (Ambrose, 2023). The current study aims to fill the gap in the literature regarding transformational giftedness.

Giftedness is categorized into transactional, which emphasizes measurable outcomes like academic success, and transformational, which focuses on creating meaningful, positive change in the world (Sternberg, 2020; 2021). Transformational gifted individuals use their talents with empathy and selflessness to improve the world (Ambrose, 2023), exemplified in the current study. Transformational giftedness is also divided into other-transformational, impacting others, and self-transformational, focusing on self-

actualization and personal growth (Sternberg et al., 2021). In the current study, gifted high school students acted as activists by developing and implementing educational content to enhance younger peers' environmental awareness. The current study demonstrates that gifted students can transform their peers' environmental awareness.

Transforming awareness of environmental concepts

Global challenges such as poverty, climate change, energy security, and environmental degradation (Grinin & Grinin, 2021; Hutton et al., 2015; Khanna et al., 2023; Lähde et al., 2023; Lund, 2015; Somogyi & Nagy, 2022) require interdisciplinary approaches, international collaboration, and transformational skills like creativity, analysis, and practical problem-solving (Hutton et al., 2015; Chapman & Aspin, 2013). Transformational giftedness, developed through acquired knowledge and skills, plays a crucial role in addressing these challenges (Sternberg, 2020).

Environmental issues are among the most urgent challenges today, making transformation in this area inevitable. Gifted students have the potential to enhance environmental awareness through their critical thinking, complex problem-solving, environmental sensitivity, interdisciplinary solutions, and metacognitive skills (Davis et al., 2013; VanTassel-Baska, 2023; Neihart et al., 2021), their greater sensitivity to moral and social issues (Cross, 2021; Silverman, 1994), and their sensitivity to environmental issues (Aydın et al., 2011; Treagust et al., 2016), high awareness of environmental problems (Mutlu et al., 2021) and their ability to offer different solution proposals from an interdisciplinary perspective (Öz Aydın & Ayverdi, 2014), high levels of metacognitive skills on topics such as recycling (Bakar et al., 2018). However, proper programs are needed to foster this potential (Renzulli, 2000). Studies also show that gifted students may exhibit lower willingness to make sacrifices for the environment and have misconceptions about global issues (Bakar et al., 2018; Özarslan, 2022). The current study investigated the impact of an educational plan, developed with the input of gifted high school students, on the environmental awareness of gifted secondary school students.

Environmental education, an important component of sustainable development, is considered the foundation of development in UNESCO's Education for a Sustainable Future program. Effective environmental education contributes to the prevention of environmental problems and the preservation of ecological balance (Taylor et al., 2009). Aiming to positively change individuals' attitudes and behaviors toward the environment, environmental education enhances senses, skills, knowledge, and behaviors (Carleton-Hug, 2010; Pooley & O'Connor, 2000). As the emphasis on the environment increases in energy and climate change education strategies, environmental education plays a role in preventing environmental problems by improving individuals' environmental attitudes, knowledge, and competence (Jorgenson et al., 2019; Liefländer & Bogner, 2018).

Various initiatives have been implemented in different countries to raise environmental awareness. Environmental education policies have been developed in Mexico (Barraza & Walford, 2002), undergraduate and graduate programs in nature management and ecology have been offered in Russia (Kasimov et al., 2005), and environmental training provided to employees in Hong Kong has yielded positive results (Law et al., 2017). In Türkiye, environmental awareness programs are implemented at all educational levels, and universities offer courses related to environmental studies, contributing to environmental education through non-governmental organizations (Ors, 2012).

Although there are numerous studies on raising awareness through environmental education, no study has been found on the transformation of environmental concepts

through transformational giftedness in gifted students. Environmental education provided to gifted students has been found to contribute positively to their sustainable living awareness, emotional and behavioral tendencies towards the environment, environmental knowledge, and sensitivity (Ayaydın et al., 2023; Nuhoğlu & İmamoğlu, 2018; Kim, 2010). In these studies, the education was planned and delivered by adults. In the current study, environmental education was planned in collaboration with gifted high school students, providing evidence of their transformation of gifted middle school students.

Significance of the study and research questions

This study aims to reveal the usability of activities planned by a teacher in collaboration with 9th-grade gifted high school students to create a transformation in the environmental awareness of 5th and 6th-grade gifted students. If a transformation in the environmental awareness of gifted students can be achieved, it is believed that the negative consequences of future environmental problems can be reduced through the environmental consciousness of these students who will have a significant role in shaping the future (Sternberg, 2020). The main difference of this study from others in the literature is that the activities aimed at transforming the environmental awareness of 5th and 6th-grade gifted students were planned by a teacher and two 9th-grade gifted high school students. The starting point of the study is based on the teacher's observation over 10 years of experience with gifted students, noting their weak awareness of environmental concepts, and sharing this observation with two gifted high school students, which led them to initiate this study. Following this, they decided to plan an environmental education program for 5th and 6th-grade middle school students. Thus, the study began with the aim of transforming gifted middle school students in this direction. The research question explored in this study are as follows: Are the activities planned by gifted 9th-grade high school students and their teachers effective in transforming the environmental education concept awareness of 5th and 6th-grade gifted students?

Method

A simultaneous nested mixed methods research model was adopted in the current study. This approach allows for the conscious and structured use of qualitative and quantitative data collection and analysis processes within the same research. This approach aimed to obtain a more in-depth and comprehensive understanding by correlating both types of data (Cresswell, 2003). In this context, both quantitative and qualitative data were collected simultaneously and evaluated holistically during the analysis process. A pretest-posttest paired control group design was used to examine the effect of the activities carried out in the experimental part on the awareness of environmental education concepts. To increase the probability of the control and experimental groups being equal, matching was done in terms of grade level and gender. In the qualitative part of the study, students' views on the activities carried out to understand their transformations regarding environmental concepts were obtained through semi-structured interviews. Interviews were conducted with 20 students in the experimental group. Additionally, the teacher's observation notes were examined. The pre-test-post-test matched control group design used in the study is presented in Table 1.

Table 1.
Research design

Group		Pre-test	Process	Post-test
Experiment	MR	Environmental Education Concepts Awareness Scale	Activities to raise awareness about environmental concepts	Environmental Education Concepts Awareness Scale
Control	MR	Environmental Education Concepts Awareness Scale	---	Environmental Education Concepts Awareness Scale

When Table 1 is examined, the students in the control and experimental groups were administered the Environmental Education Concepts Awareness Scale as a pre-test and post-test. In the experimental group, activities planned by two gifted high school students and their teachers were carried out, while no application was made in the control group.

Population and Sample

The target population of the study is the students of the Science and Art Center (SAC) in Türkiye. SACs are institutions where gifted students receive education in line with their abilities, interdisciplinary thinking, scientific work, and project development for the problems they face (Ministry of National Education in Türkiye [MoNE], 2019). SAC offers specialized education for gifted students from primary to high school, focusing on nurturing their potential through a project-based approach. The selection process involves three stages: student nomination by their school teacher, a group intelligence test, and an individual intelligence test for those who pass the initial assessment. Students with a total IQ score exceeding 130 are eligible for SAC enrollment. The education model emphasizes adaptability, support, recognition of individual talents, developing special abilities, and project programs. SAC's unique approach integrates this education alongside regular schooling, providing a tailored program during non-formal hours. While the core curriculum is predetermined, implementation methods are flexible (Şahin et al., 2023).

The accessible population of this study consists of gifted students enrolled in Science and Art Centers (SACs) within the province where the research was carried out. The sample includes 5th and 6th grade gifted students attending a SAC located in the provincial center. The participants were selected using a convenience sampling method, which is a non-probability technique where participants are chosen based on their ease of accessibility (Etikan et al., 2016; Suen et al., 2014). This approach is often preferred when time and resources are limited, offering a practical alternative to random sampling (Speak et al., 2018). Tables 2 and 3 present the distribution of the students by grade level and gender.

Table 2.
Distribution of the sample by gender

Gender	Experiment	Control	Total
Female	7	9	16
Male	13	10	23
Total	20	19	39

Table 3.
Distribution of the sample according to grade level

Class level	Experiment	Control	Total
Grade 5	11	9	20
Grade 6	9	10	19
Total	20	19	39

When Table 2 is examined, it is seen that 7 of the 20 gifted students in the experimental group were female and 13 were male, while 9 of the 19 gifted students in the control group were female and 10 were male.

When Table 3 is analyzed, 11 of the 20 gifted students in the experimental group were in 5th grade, and 9 were in 6th grade. Of the 19 gifted students in the control group, 9 were in 5th grade and 10 were in 6th grade. The reason for selecting 5th and 6th grade students in the sample is that it is desired to start from the youngest age group as much as possible in terms of raising awareness among students. Since the youngest age group for the middle school group was grades 5 and 6, the study was conducted with students in this group.

Teacher profile

The science teacher in this study has 15 years of experience, including 10 years with gifted students, and holds a bachelor's and doctorate in science education. The teacher

has conducted environmental education research, knows students and families well, and adapts teaching to students' needs while maintaining high academic expectations.

Gifted students working with the teacher in planning and implementation

The two 9th-grade gifted students have studied at SAC for six years. One female and one male have collaborated on projects such as biodegradable plastic synthesis and natural fungicide production, earning national and international awards. They also have six years of experience working with the teacher in this study.

Data sources and analysis process

Environmental Education Concepts Awareness Scale (EECA)

The Environmental Education Concepts Awareness Scale (EECA) was developed by Ötün et al. (2017). The scale consists of 22 items and 6 factors. The first factor is “Greenhouse Effect”, the second factor is “Human Impact”, the third factor is “Causes of Global Warming”, the fourth factor is “Environmental Pollution”, the fifth factor is “Environmental Awareness”, and the sixth factor is “Importance of Environmental Protection”. The scale is a 5-category rating scale. In the current study, this scale was used as a pre-test and post-test.

Semi-Structured Interview Form (SSIF)

Semi-structured interviews were conducted to explore students’ transformation processes and their views on the activities. The interview form consisted of open-ended questions designed to capture students’ perceptions of the activities and their transformation. The questions were reviewed by three experts, and revisions were made based on their feedback before finalizing the form. Semi-structured interviews were conducted with 20 students, and audio recordings were obtained with participants’ consent. Each interview lasted approximately 15 minutes. After the audio recordings were transcribed, they were coded, and themes were created.

Classroom observations

Following the planning of the implementation process, comprehensive classroom observation field notes were recorded by the teacher over an eight-week period (640 minutes). The entire implementation process was carried out by gifted high school students. Detailed notes were taken on conversations, behaviors, and learning activities conducted during the sessions. At the end of each day, the observation notes were transcribed, reviewed, and supplemented with additional reflections. Any emerging questions were posed to the high school students in the following week. The observation notes and recorded dialogues were analyzed inductively to identify emerging themes (Merriam, 2009).

Experimental process

Before the experimental research, two gifted high school students and the teacher investigated what kinds of activities could be done to increase students' awareness of environmental concepts. After the literature review, the students and the teacher interviewed two academicians who had studied in the field of environmental education and giftedness, and as a result of this interview, it was determined that activities could be included in which high school students had previous project work experience and experiments related to the environment. Upon the suggestion of the academician who

had experience in environmental education, it was determined that game-type studies could also be included. In terms of selecting the games, the suggestions of the academicians were again sought. Upon the suggestion of high school students, it was decided that a seminar would be given by an expert in this field to raise awareness among students. Thus, the activities to be carried out for 8 weeks were determined. First of all, the necessary legal permissions for the study were obtained with the letter of the Provincial Directorate of National Education dated 16.03.2022. During the implementation phase of the activities, gifted high school students and the teacher guided the gifted 5th and 6th-grade students. Students actively participated in the activities. Information on the activities carried out throughout the study is presented in Table 4.

Table 4.
Activities carried out

Activity Name	Week/Duration (class hour)	Learning Objectives	Relationship with Environmental Concepts Awareness
Why use bioplastic?	Week-1/80 min. (2 class hours)	1. Analyzes the effects of plastics on environmental pollution. 2. Synthesizes bioplastics that can be used instead of plastics. 3. Develops environmental awareness.	Environmental pollution Environmental awareness Importance of protecting the environment
Is it possible to prevent chemical fertilizer pollution?	Week-2/80 min. (2 class hours)	1. Analyzes the effects of chemical fertilizers on environmental pollution. 2. Produces natural fertilizers that can be used instead of chemical fertilizers. 3. Develops environmental awareness.	Environmental pollution Environmental awareness Importance of protecting the environment
Let's clean polluted waters!	Week-3 and 4/160 min. (4 class hours)	1. Analyzes the causes of water pollution. 2. Creates a design to clean polluted waters. 3. Develops environmental awareness. 4. Discusses the importance of protecting the environment.	Environmental pollution Environmental awareness Importance of protecting the environment
The future of the World board game	Week-5/80 min. (2 class hours)	1. Evaluates the causes of global warming. 2. Discusses the negative effects of humans on the environment. 3. Discusses the greenhouse effect.	Greenhouse effect Human effect Causes of global warming
Global climate change and environmental awareness seminar	Week-6/80 min. (2 class hours)	1. Discusses the effects of global climate change on the environment. 2. Develops awareness of environmental concepts.	Causes of global warming Environmental awareness
Environmental concepts awareness with games	Week-7/80 min. (2 class hours)	1. Develops awareness of environmental concepts. 2. Analyzes the importance of protecting the environment.	Environmental awareness The importance of protecting the environment
Environmental concepts awareness with drama	Week-8/80 min. (2 class hours)	1. Develops awareness of environmental concepts. 2. Evaluates the importance of protecting the environment.	Environmental awareness The importance of protecting the environment
Total	8 weeks/640 min. (16 class Hours)		

When Table 4 is examined, it is seen that the activities planned by gifted high school students and their teachers with expert support lasted 8 weeks (640 minutes) and the activities were aimed at developing awareness of environmental concepts.

Results

Initially, the study investigated whether there was a statistically significant difference between the control and experimental groups in terms of their pre-test scores on environmental education concept awareness. For this analysis, both the total score and the sub-dimension scores from the Environmental Education Concepts Awareness Scale were utilized. For this purpose, independent sample t-test was applied. The analysis results are presented in Table 5.

Table 5.
Comparison of the pre-test scores of the control and experimental groups obtained using the environmental education concepts awareness scale

Scores	Groups	n	Mean	SD	df	t	p
Greenhouse Effect	Experiment	20	18.25	2.59	37	-.018	.986
	Control	19	18.26	1.82			
Human Influence	Experiment	20	14.19	1.88	37	.689	.495
	Control	19	13.84	1.12			
Causes of Global Warming	Experiment	20	16.75	2.83	37	.401	.691
	Control	19	16.42	2.24			
Environmental Pollution	Experiment	20	12.60	2.95	37	.767	.448
	Control	19	12.00	1.76			
Environmental Awareness	Experiment	20	17.50	3.27	37	1.094	.281
	Control	19	16.58	1.71			
The Importance of Protecting the Environment	Experiment	20	13.25	1.45	37	1.576	.124
	Control	19	12.21	2.55			
Total Score	Experiment	20	92.54	10.13	37	1.165	.252
	Control	19	89.32	6.70			

When Table 5 is analysed, it is seen that before the activity, greenhouse effect (t=-.018 p>.05), human effect (t=.689, p>.05), causes of global warming (t=.401, p>.05), environmental pollution (t=. 767, p>.05), environmental awareness (t=1.094, p>.05), importance of protecting the environment (t=.1.576, p>.05) and total (t=1.165, p>.05) scores did not create a statistically significant difference.

A paired samples t-test was performed to determine whether there was a meaningful difference between the pre-test and post-test scores on environmental education concept awareness among the gifted students in the experimental group. The results are displayed in Table 6.

Table 6.
Comparison of pre-test and post-test in terms of environmental education concepts awareness of the experimental group

Scores	Test	n	Mean	SD	df	t	p	Cohen d
Greenhouse Effect	Pre-test	20	18.25	2.59	19	-5.201	.000	1.039
	Post-test	20	20.84	2.38				
Human Influence	Pre-test	20	14.19	1.88	19	-.673	.509	.205
	Post-test	20	14.50	1.05				
Causes of Global Warming	Pre-test	20	16.75	2.83	19	-2.390	.027	0.717
	Post-test	20	18.50	1.96				
Environmental Pollution	Pre-test	20	12.60	2.95	19	-2.189	.041	0.551
	Post-test	20	13.95	.76				
Environmental Awareness	Pre-test	20	17.50	3.27	19	-2.046	.055	0.557
	Post-test	20	18.95	1.15				
The Importance of Protecting the Environment	Pre-test	20	13.25	1.45	19	-1.291	.212	0.392
	Post-test	20	13.80	1.36				
Total Score	Pre-test	20	92.54	10.13	19	-4.436	.000	0.820
	Post-test	20	100.54	4.04				

When Table 6 is examined, it is seen that there is a statistically significant difference in the post-test and pre-test scores of the students in the experimental group according to the greenhouse effect (t=-5.201, p<.05), the causes of global warming (t=-2.390, p<.05), environmental pollution (t=-2.189, p<.05) and total (t=-4.436, p<.05) scores. The differences are in favour of the post-test. When the effect sizes were examined, it was calculated that the values obtained in the greenhouse effect and total score had large

effects; the values obtained in the causes of global warming and environmental pollution had medium effects (Cohen, 2008). However, although there was no significant difference between pre-test and post-test scores in terms of human impact (t=-.673, p>.05), environmental awareness (t=-2.046, p>.05) and the importance of protecting the environment (t=-1.291 p>.05), it was observed that post-test scores were higher than pre-test scores.

A paired samples t-test was performed to determine whether there was a meaningful difference between the pre-test and post-test scores on environmental education concept awareness among the gifted students in the control group. The results are displayed in Table 7.

Table 7.
Comparison of pre-test and post-test in terms of environmental education concepts awareness of the control group

Scores	Test	n	Mean	SD	sd	t	p	Cohen d
Greenhouse Effect	Pre-test	19	18.26	1.82	18	-2.687	.015	0.087
	Post-test	19	20.42	2.81				
Human Influence	Pre-test	19	13.84	1.12	18	-.946	.357	0.276
	Post-test	19	14.16	1.17				
Causes of Global Warming	Pre-test	19	16.42	2.24	18	-.818	.424	0.258
	Post-test	19	17.16	3.10				
Environmental Pollution	Pre-test	19	12.00	1.76	18	-1.761	.095	0.521
	Post-test	19	12.95	1.87				
Environmental Awareness	Pre-test	19	16.58	1.71	18	-.824	.420	0.257
	Post-test	19	17.16	2.41				
The Importance of Protecting the Environment	Pre-test	19	12.21	2.55	18	.381	.707	0.104
	Post-test	19	11.79	3.41				
Total Score	Pre-test	19	89.32	6.70	18	-1.509	.149	0.446
	Post-test	19	93.63	9.42				

When Table 7 is examined, it is seen that there is a significant difference according to the greenhouse effect (t=-2.687, p<.05) scores of the students in the control group. However, when the effect size is examined, it is interpreted as having no effect since the Cohen d value is less than 0.2 (Cohen, 2008). Human effect (t=-.946, p>.05), causes of global warming (t=-.818, p>.05), environmental pollution (t=-1.761, p>.05), environmental awareness (t=-.824, p>.05), importance of protecting the environment (t=-1.381, p>.05) and total (t=-1.381, p>.05). 761, p>.05), environmental awareness (t=-.824, p>.05), importance of protecting the environment (t=.381, p>.05) and total (t=-1.509, p>.05) scores, there was no significant difference between post-test and pre-test scores.

To assess whether there was a significant difference in post-test scores on environmental education concept awareness between the experimental and control groups of gifted students, an independent samples t-test was carried out. The results are presented in Table 8.

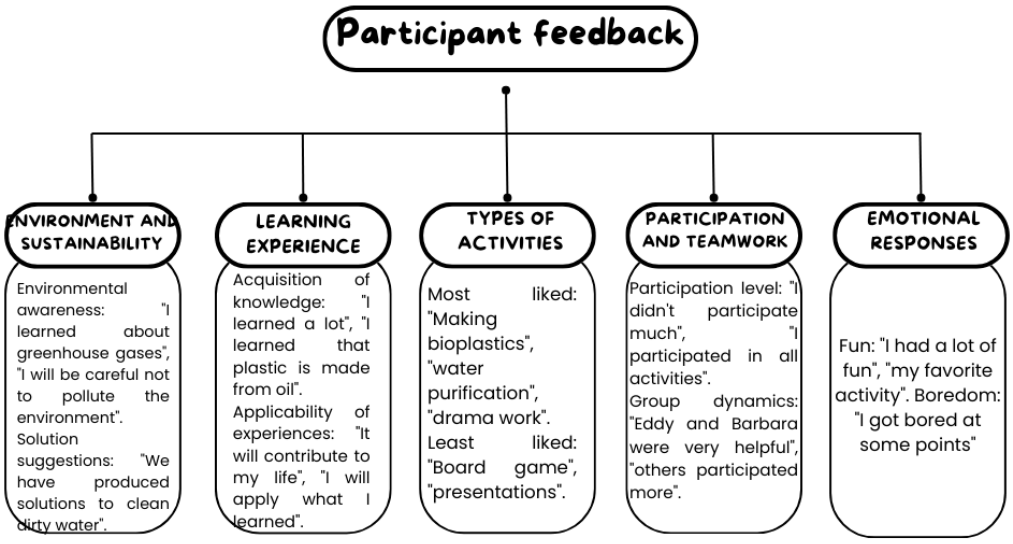
Table 8. Comparison of the post-test scores of the control and experimental groups obtained using the environmental education concepts awareness scale.

Scores	Groups	n	Mean	SD	df	t	p	Cohen d
Greenhouse Effect	Experiment	20	20.84	2.38	37	.505	.617	0.162
	Control	19	20.42	2.81				
Human Influence	Experiment	20	14.50	1.05	37	.963	.342	0.306
	Control	19	14.16	1.17				
Causes of Global Warming	Experiment	20	18.50	1.96	37	1.626	.112	0.520
	Control	19	17.16	3.10				
Environmental Pollution	Experiment	20	13.95	.76	37	2.173	.040	0.707
	Control	19	12.95	1.87				
Environmental awareness	Experiment	20	18.95	1.15	37	2.941	.007	0.956
	Control	19	17.16	2.41				
The importance of protecting the environment	Experiment	20	13.80	1.36	37	2.396	.025	0.782
	Control	19	11.79	3.41				
Total score	Experiment	20	100.54	4.04	37	2.950	.007	0.962
	Control	19	93.63	9.42				

When Table 8 is analysed, it is seen that there is no statistically significant difference between the control and experimental groups in terms of greenhouse effect (t=.505, p>.05), human effect (t=.963, p>.05) and causes of global warming (t=1.626, p>. 05), but there was a difference in favour of the experimental group in terms of environmental pollution (t=2.173, p<.05), environmental awareness (t=2.941, p<.05), importance of protecting the environment (t=2.396, p<.05) and total (t=2.950, p<.05) scores. When the effect sizes are examined, a large effect was calculated in environmental awareness and total scores, and an intermediate effect was calculated in the importance of environmental pollution and the importance of protecting the environment (Cohen, 2008).

The views of gifted students on the impact of the activities in transforming their awareness of environmental concepts were examined, and the findings are presented in Figure 1. An analysis of Figure 1 shows that students' views are categorized under five main themes: Environment and Sustainability, Learning Experience, Types of Activities, Participation and Teamwork, and Emotional Responses.

Figure 1.
Students' views on the effects of activities on the transformation of their awareness of environmental concepts



An analysis of Figure 1 shows that the first theme, Environment and Sustainability, is reflected in the views of Student 1 as follows:

> "These were the best activities I experienced at SAC. Eddy and Barbara (pseudonyms) were very helpful, and what they taught us was valuable. I will be more careful about environmental pollution and will advise my family against using harmful fuels like coal. The activities were fun, never boring, and included outdoor tasks, slides, and information on plastics, bioplastics, and hydrogels." (Student1, male/S1M).

For the second theme, Learning Experience, Student 3 expressed the following views:

> "I had a lot of fun and found the eight-week activities very beneficial. I learned new information, conducted many experiments, and especially enjoyed the informative interview with Amir from Evrim Ağacı (pseudonym), particularly on climate change. I also learned that plastics are derived from petroleum. Thank you for informing us." (S3F).

For the third theme, Types of Activities, Student 5 shared the following views:

> "These activities were great. I especially enjoyed the games we played the most. I also liked the experiment where we made bioplastic." (S5F).

For the fourth theme, Participation and Teamwork, Student 12 expressed the following views:

> "Among the activities we did, I enjoyed the drama activity the most and learned a lot of different information. There was a high level of group interaction during the drama sessions, and we also learned from each other. Eddy and Barbara were very helpful, and I would like to thank them" (S12F).

For the fifth theme, Emotional Responses, Student 7 shared the following views:

> "Among the activities we did, I enjoyed the experiments and the interview with Evrim Ağacı the most. I had a lot of fun. I wish we had more time to conduct more experiments" (S7M).

Student views indicate that sustainability themes fostered awareness and problem-solving skills, while learning experiences enhanced environmental consciousness and potential behavioral change. Applied activities were favored over static ones, teamwork boosted participation, and enjoyable activities increased motivation despite some static parts being less engaging.

The teacher's observation notes on the implementation of the activities were categorized into four themes: Environmental Concepts and Sustainability, Personal Experiences, Transformational Giftedness, and Emotional Experiences.

For the first theme, Environmental Concepts and Sustainability, the teacher noted:

> "High school students emphasized environmental concepts, particularly sustainability, while discussing the outcomes of the experimental activities. They also linked the topic to sustainability during the drama activity. Selecting the game within the framework of sustainability further enhanced awareness of environmental concepts. The global climate change and environmental awareness seminar was the right choice."

Regarding the second theme, Personal Experiences, the teacher observed:

> "Students reflected their previous project experiences related to bioplastic synthesis, the use of natural fertilizers instead of chemical ones, and the purification of polluted water during the experimental activities, which made the process more enjoyable for them."

For the third theme, Transformational Giftedness, the teacher noted:

> "High school students utilized peer learning to transform the environmental concept awareness of middle school students."

Finally, for the fourth theme, Emotional Experiences, the teacher recorded:

> "The facial expressions of gifted middle school students reflected that they were having fun and enjoying the activities. Seeing high school students as role models made them feel good."

Discussion

This research explored the impact of activities planned by a teacher and 9th-grade gifted high school students on transforming the environmental awareness of 5th and 6th-grade gifted students. The findings emphasize the crucial role of high school students in designing and implementing these activities, highlighting the value of involving students

in co-creating educational programs. This participatory approach fostered a sense of ownership.

The research findings indicate that the implemented activities significantly improved students' awareness regarding environmental issues. In the experimental group, a comparison of pre-test and post-test scores revealed statistically significant and positive differences in the areas of greenhouse effect, causes of global warming, environmental pollution, and overall scores. Notably, large effect sizes were observed in the greenhouse effect and total scores, indicating a strong impact of the activities. In contrast, the control group showed a significant difference only in the greenhouse effect dimension, but the effect size was minimal. When comparing the experimental and control groups, the experimental group demonstrated significantly greater improvement in environmental pollution, environmental awareness, importance of protecting the environment, and total scores. These findings demonstrate that the implemented activities increased students' awareness of environmental concepts, indicating that gifted students were able to transform their gifted peers in terms of awareness of environmental concepts.

The educational program implemented in this study reflects Sternberg's (2020) framework for transformational giftedness, which highlights the importance of fostering meaningful, positive societal changes through education. The experimental activities encouraged students to move beyond transactional learning, focused solely on academic outcomes, and embrace a transformational approach, channeling their knowledge and skills to address real-world environmental problems. This aligns with Sternberg's (2024) ecological levels of transformation, particularly at the microsystem level, where individuals directly impact their immediate surroundings, such as their schools and local communities.

The inclusion of experimental activities related to bioplastic synthesis, natural fertilizers, and water purification provided middle school students with hands-on learning experiences, reinforcing the importance of experiential learning in science education (Kolb, 2014). Applied activities like bioplastic synthesis, water purification, and educational games effectively engaged students and reinforced theoretical concepts, aligning with active learning strategies highlighted in the literature (Öz Aydın & Ayverdi, 2014; Aydın et al., 2011; Ayaydın et al., 2023; Mutlu et al., 2021; Nuhoğlu & İmamoğlu, 2018; Kim, 2010; Treagust et al., 2016; Uğurlu, 2019).

The results of the current study are not consistent with the results of studies indicating that gifted students have a lower capacity to make sacrifices and make efforts for the environment compared to their peers (Bakar et al., 2018), cannot focus on global environmental problems (Nacaroğlu & Bozdağ, 2020), and do not want to deal with global problems (Özarslan, 2022). This may be due to the difference in methods used when providing environmental education to students. In the current study, the application, which can be an example of peer-led transformational giftedness, may have increased the motivation of gifted students to work on environmental issues. The fact that they thanked the gifted 9th-grade students who carried out the application in the student interviews can be considered an indicator of this.

Furthermore, the incorporation of sustainability concepts throughout the activities, including drama and game-based learning, demonstrates an innovative approach to environmental education. The selection of a sustainability-themed game, as noted by the teacher, contributed significantly to raising students' awareness of environmental issues. This finding is consistent with previous studies indicating that interactive and creative

teaching methods can enhance students' engagement and learning outcomes in environmental education (Ardoin et al., 2018).

The emotional engagement of students, as evidenced by their positive facial expressions and enjoyment during the activities, highlights the affective dimension of learning. Positive emotional experiences have been shown to enhance motivation and deepen learning (Pekrun et al., 2002), suggesting that the enjoyable and interactive nature of the activities contributed to the students' overall learning experience.

When evaluated through the lens of Sternberg's theory of transformational giftedness, the teacher's observations offer compelling evidence that the environmental education program nurtured not only cognitive development but also ethical responsibility and social influence—core components of transformational giftedness. According to Sternberg et al. (2021) gifted individuals should strive not just for personal success but for positively transforming others and society at large. In this study, high school students acted as catalysts for change by intentionally guiding and enhancing the environmental concept awareness of their younger peers. This peer-led transformation is a clear manifestation of transformational giftedness, where knowledge is used as a tool for social betterment. Moreover, students' incorporation of personal project experiences and their emotional engagement with the activities show a deep internalization of both content and values. The observed enjoyment, motivation, and meaningful peer interaction underscore the role of affective and social dimensions in fostering a sense of responsibility beyond oneself. In this sense, the educational design effectively created a context where gifted students not only learned but also led, inspired, and empowered—hallmarks of transformational giftedness as envisioned by Sternberg.

In the current study, the impact of environmental education on gifted students' awareness of environmental concepts within a specific regional context was investigated. Given the contextual specificity, there is a need for further research to generalize the findings across different populations and settings. The sample in this study comprised a total of 39 students, which constitutes a relatively limited participant pool. Therefore, future research should aim to include larger and more diverse sample groups to enhance the generalizability of the results.

Subsequent studies are encouraged to place greater emphasis on the development of behavioral and emotional dimensions of environmental learning, particularly in areas such as human impact and environmental protection. Incorporating reflective journaling, community-based projects, and emotionally engaging storytelling strategies tailored for gifted students may foster deeper cognitive and affective engagement. Furthermore, educational policy frameworks should consider integrating peer-led and interdisciplinary environmental education programs that promote not only environmental awareness but also transformational giftedness, leadership skills, critical thinking, and a strong sense of ethical responsibility.

References

Ambrose, D (2023). Interdisciplinary insights that reveal contextual influences on the development of giftedness and talent. Educ. Sci., 13, 690-703. https://doi.org/10.3390/educsci13070690

Ardoin, NM, Bowers, AW, Roth, NW, & Holthuis, N (2018). Environmental education and K-12 student outcomes: A review and analysis of research. The Journal of Environmental Education, 49(1), 1-17. https://doi.org/10.1080/00958964.2017.1366155

Ayaydın, Y, Gezer, SU, & Sesen, BA (2023). A Study on sustainable living awareness of gifted secondary school students. Research on Education and Psychology, 7(Special Issue 2), 602-624. https://doi.org/10.54535/rep.1363669

Aydın, F, Coskun, M, Kaya, H, & Erdonmez, I (2011). Gifted students' attitudes towards environment: A case study from Turkey. African Journal of Agricultural Research, 6(7), 1876-1883. https://doi.org/10.5897/AJAR11.288

Bakar, F, Avan, Ç, & Aydınlı, B (2018). The attitude comparison of gifted students and normal peers on the recycling and environmental effects. Kastamonu Education Journal, 26(3), 935-944.

Barraza, L, & Walford, RA (2002). Environmental education: A comparison between English and Mexican school children. Environmental Education Research, 8(2), 171-186. https://doi.org/10.1080/13504620220128239

Carleton-Hug, A, & Hug, JW (2010). Challenges and opportunities for evaluating environmental education programs. Evaluation and Program Planning, 33(2), 159-164. https://doi.org/10.1016/j.evalprogplan.2009.07.005

Chapman, JD, & Aspin, DN (2013). A problem-solving approach to addressing current global challenges in education. British Journal of Educational Studies, 61(1), 49-62.

Cohen, B (2008). Explaining psychological statistics (3rd ed.). John Wiley& Sons.

Cresswell, JW (2003). A framework for design. In J. W. Cresswell (Ed.), Research design: Qualitative, quantitative, and mixed methods approaches (pp. 3–26). Sage.

Cross, JR (2021). Gifted children and peer relationships. In M Neihart, SI Pfeiffer, & TL Cross (Eds), The social and emotional development of gifted children (pp. 41-54). Routledge.

Davis, GA, Rimm, SB, & Siegle, DB (2013). Education of the gifted and talented: Pearson new international edition. Pearson Higher Ed.

Etikan, I, Musa, SA, & Alkassim, RS (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1-4.

Gagné, F (2010). Motivation within the DMGT 2.0 framework. High Ability Studies, 21(2), 81-99.

Gardner, HE (2011). Frames of mind: The theory of multiple intelligences. Basic books.

Grinin, AL, & Grinin, LE (2021). Analyzing the global problems of the twenty-first century. A review and forecast based on the report to the Club of Rome 'Come On!'. Journal of Globalization Studies, 12(2), 181-195.

Hutton, FG, Feulner, G, ..., & Butler, D (2015). Global Challenges–an innovative journal for tackling humanity's major challenges. Global Challenges, 1(1), 3.

Jorgenson, SN, Stephens, JC, & White, B (2019). Environmental education in transition: A critical review of recent research on climate change and energy education. The Journal of Environmental Education, 50(3), 160-171. https://doi.org/10.1080/00958964.2019.1604478

Kasimov, NS, Malkhazova, SM, & Romanova, EP (2005). Environmental education for sustainable development in Russia. Journal of Geography in Higher Education, 29(1), 49-59. https://doi.org/10.1080/03098260500030363

Khanna, MK, Malik, S, & Kumar, H (2023). Indian solar panel initiatives in reducing carbon dioxide emissions. Energy and Power Engineering, 15(4), 191-203. https://doi.org/10.4236/epe.2023.154009.

Kim, SS (2010). The effect of volunteer work at the place of ecology experience on the environmental sensitivity & state-trait anxiety of the gifted students. Journal of Environmental Science International, 19(5), 655-663.

Kolb, DA (2014). Experiential learning: Experience as the source of learning and development. FT press.

Law, MMS, Hills, P, & Hau, BCH (2017). Engaging employees in sustainable development–a case study of environmental education and awareness training in Hong Kong. Business Strategy and the Environment, 26(1), 84-97. https://doi.org/10.1002/bse.1903

Lähde, V, Vadén, T, ..., & Eronen, JT (2023). The crises inherent in the success of the global food system. Ecology and Society, 28(4), 16. https://doi.org/10.5751/ES-14624-280416

Liefländer, AK, & Bogner, FX (2018). Educational impact on the relationship of environmental knowledge and attitudes. Environmental Education Research, 24(4), 611-624. https://doi.org/10.1080/13504622.2016.1188265

Lund, PD (2015). Global Challenges: Energy. Global Challenges, 7-8.

Marland, SP (1972). Education of the Gifted and Talented. (2 Vols.). Reportto congress of the United States Commissioner of Education. US Government Printing Office.

Merriam, SB (2009). Qualitative research: A guide to design and implementation. Jossey-Bass.

Ministry of National Education in Türkiye, MEB (2019). Bilim ve Sanat Merkezleri Yönergesi [Science and Art Centres Directive]. http://menderes.meb.gov.tr/meb_iys_dosyalar/2020_11/26154916_Bilim_ve_Sanat_Merkezleri_Yonergesi_2019.pdf

Mutlu, F, Nacaroğlu, O, & Doğan, M (2021). Awareness of the gifted students and their normally developing peers about environmental education concepts. Acta Didactica Napocensia, 14(1), 2-16. https://doi.org/10.24193/adn.14.1.1

Nacaroğlu, O, & Bozdağ, T (2020). An investigation into the perceptions of gifted students on environmental problems by using word association test. Gazi University Gazi Education Fakulty Journal, 40(2), 385-409.

Neihart, M, Pfeiffer, SI, & Cross, TL (2021). What have we learned and what should we do next? In M Neihart, SI Pfeiffer, & TL Cross (Eds.), The social and emotional development of gifted children (pp. 283-298). Routledge.

Nuhoğlu, H, & İmamoğlu, Y (2018). An interdisciplinary nature education program for gifted primary school students and its effect on their environmental literacy. Elementary Online, 17(4), 1928-1943.

Ors, F (2012). Environmental education and the role of media in environmental education in Turkey. Procedia-Social and Behavioral Sciences, 46, 1339-1342. https://doi.org/10.1016/j.sbspro.2012.05.298

Ötün, Y, Artun, H, Temur, A, & Tozlu, İ (2017). Environmental education concepts awareness scale for secondary school students: A validity and reliability study. YYU Journal of Education Faculty,16(1), 511-528. https://doi.org/10.23891/efdyyu.2017.20

Öz Aydın, S, & Ayverdi, L (2014). The comparison of proposing solutions of the students who attend and don't attend the science

and art institution to an environmental problem in terms of scientific creativity. Journal of Turkish Science Education, 11(1), 25-41. https://doi.org/10.12973/tused.10101a

Özarslan, M (2022). Environmental problems according to the gifted and talented students and their solution proposals: Qualitative research. International Journal of New Trends in Arts, Sports & Science Education (IJTASE), 11(4), 201-216.

Pekrun, R, Goetz, T, Titz, W, & Perry, RP (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. Educational psychologist, 37(2), 91-105. https://doi.org/10.1207/S15326985EP3702_4

Pooley, JA, & o'Connor, M (2000). Environmental education and attitudes: Emotions and beliefs are what is needed. Environment and Behavior, 32(5), 711-723. https://doi.org/10.1177/0013916500325007

Renzulli, JS (1978). What makes giftedness? Reexamining a definition. Phi Delta Kappan,60, 18-24.

Renzulli, JS (2000). The identification and development of giftedness as a paradigm for school reform. Journal of Science Education and Technology, 9, 95-114.

Silverman, LK (1994). The moral sensitivity of gifted children and the evolution of society. Roeper Review, 17(2), 110-116. https://doi.org/10.1080/02783199409553636

Somogyi, T, & Nagy, R 2022. Some impacts of global warming on critical infrastructure protection - heat waves and the European financial sector. Insights into Regional Development, 4(4), 11-20. https://doi.org/10.9770/IRD.2022.4.4(1)

Speak, A, Escobedo, FJ, Russo, A, & Zerbe, S (2018). Comparing convenience and probability sampling for urban ecology applications. Journal of Applied Ecology, 55(5), 2332-2342.

Sternberg, RJ (1999). The theory of successful intelligence. Review of General Psychology, 3(4), 292-316

Sternberg, RJ (2020). Transformational giftedness: rethinking our paradigm for gifted education. Roeper Review, 42(4), 230-240, https://doi.org/10.1080/02783193.2020.1815266

Sternberg, RJ (2021). Transformational vs. transactional deployment of intelligence. Journal of Intelligence, 9, 1-16. https://doi.org/10.3390/jintelligence9010015

Sternberg, RJ, Chowkase, A, ..., & Lu, J (2021). Beyond transformational giftedness. Education Sciences, 11(5), 192. https://doi.org/10.3390/educsci11050192

Sternberg, RJ (2024). Transformational giftedness in action: Paths to positive, meaningful, and potentially enduring societal change. Roeper Review, 46(4), 292-303, https://doi.org/10.1080/02783193.2024.2392238

Suen, LJ, Huang, HM, & Lee, HH (2014). A comparison of convenience sampling and purposive sampling. Hu Li Za Zhi, 61(3), 105.

Şahin, H, Karataş, S, ..., & Azeken, N (2023). A Systematic compilation of the problems encountered by teachers and students in Science and Arts Centers in Turkey. Sustainability, 15(3), 2537. https://doi.org/10.3390/su15032537

Taylor, N, Littledyke, M, ..., & Coll, R (2009). Environmental education in context: An international perspective on the development of environmental education. Sense Publishers.

Terman, LM (1916). The measurement of intelligence: An explanation of and a complete guide for the use of the stanford revision and extension of the binet-simon intelligence scale. Houghton Mifflin.

Terman, LM (1925). Genetic studies of genius: mental and physical traits of a thousand gifted children. Stanford University Press.

Treagust, DF, Amarant, A, Chandrasegaran, AL, & Won, M (2016). A Case for enhancing environmental education programs in schools: reflecting on primary school students' knowledge and attitudes. International Journal of Environmental and Science Education, 11(12), 5591-5612.

Uğurlu, I (2019). Efficacy of recycling education integrated with ecology course prepared within the context of enrichment among gifted students. International Journal of Educational Sciences, 26(1-3), 49-58.

VanTassel-Baska, J (2023). Introduction to the Integrated Curriculum Model. In J. VanTassel-Baska & C. A. Little (Eds.), Content-based curriculum for advanced learners (4th ed., pp. 17-37). Routledge.