



## Raising Zero Waste Awareness with Originally Designed Educational Games and Pre-service Teachers' Views on Practice\*

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Article Information	ABSTRACT
Received: 03.01.2023	This study aimed to examine the effects of originally designed educational games on the Zero Waste awareness levels of science pre-service teachers and to determine the opinions of pre-service teachers about the practice process. A mixed-method research model, using both quantitative and qualitative research methods, was employed to obtain data. The study employed a semi-experimental design with a pretest – posttest control group to collect quantitative data and a semi-structured interview technique to obtain qualitative data. The study group consisted of 40 pre-service science teachers studying in the third year of a state university in Turkey during the fall semester of the 2021-2022 academic year. The first result of the study showed that there was no significant difference between the pre-test scores of the experimental and control groups, but a significant difference was found between the post-test scores in favor of the experimental group. According to the pre-service teachers, the “Kullan At’ma (Don’t Dispose)” game was the most enjoyable, while “Düşün, Net, Kağıdı Yok Et (Think Clear, Destroy Paper)” was the most difficult. The games played provided cognitive, affective and psychomotor gains.
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### 1. INTRODUCTION

According to Gaia Theory, the earth is a living planet. All living creatures in the world, including the air, oceans, fresh water, and forests, are physically interrelated. Trees, lakes, seas, animals, and plants in the world interact with each other. Therefore, an impact done to one of these components affects the whole world. These impacts, done to each component of the world, rise quickly due to the rapid increase in population and industrialization. These effects bring together many problems such as ecosystem destruction, climate change, ozone depletion, greenhouse effect, famine, decrease in biodiversity, and deforestation. One of the issues that occur as a result of these effects is the annihilation problem (Onder & Guven Yildirim, 2021). Waste can be classified according to various characteristics such as consumption, production, chemical and physical properties, as well as solid, liquid, and gaseous waste. Waste is defined as a waste from any source (commercial, domestic, or industrial), losing its usefulness after usage of raw material, fuel, and water and thus losing its economic value for an individual (Read, 1999). According to statistical data, a person consumes an average of 435 kg of waste per year (Zaman & Swapan, 2016) and only 15% of the waste which emerges globally is recycled. 85% of its part is thrown into waste storage (Zaman, 2016). Waste thrown into waste storage, causes greenhouse gas emissions and puts water bodies, soils, vegetation, and human health at risk (Sjöström & Östblom, 2010). It also causes rapid depletion of natural resources contrary to sustainability.

To solve the waste problem, one of the most foresighted concepts is zero waste (Zaman & Lehmann, 2013). The term zero waste was used in public opinion as (Zero Waste System), which is the name of the company founded by Paul Palmer at the beginning of the 70s for the first time (Palmer, 2022). However, Paul Palmer, instead of environmental worries, founded a zero-waste company after recognizing the factory's clean and usually valuable chemical waste and brought this term up. This concept, which

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is commonly used today to wash away environmental problems, was founded because of financial and scientific reasons in those days (Mauch, 2016). Zero waste today encourages the creation of innovative methods and their application for minimizing waste and protecting resources throughout the lifecycle. It encourages products to be redesigned for being used many times until raw materials reach their optimum levels. In this system, no material is wasted, but they used as an input, and it replaces the need for mining of natural sources. For this reason, the zero-waste concept is based on using resources instead of creating waste (Cole, Osmani, Quddus, Wheatley, & Kay, 2014). The zero waste perspective is not just about washing away consumed products, but it is about re-involvement of them into the domestic production process (Montalvo, 2003; Rennings, 2000; Zaman & Lehmann, 2011), and re-use in other areas (Smol, Kulczycka, & Kowalski, 2016; Strazza, Magrassi, Gallo, & Del, 2015). Nevertheless, it is seen that zero waste in the dimension of just recycling today (Ghisellini, Cialani, & Ulgiati, 2016).

### **1.1. Statement of the Problem**

Nowadays, people are concerned about environmental problems and the rapid consumption of natural sources (Musova, Musa, & Matiova, 2021). Despite these concerns, people's consumption preferences contribute to environmental problems and the depletion of naturel sources (Yahya, Musa, & Hashim, 2014). To prevent environmental problems and the depletion of naturel resources, zero waste should be implemented as a lifestyle. Raising awareness of this issue is necessary to internalize zero waste as a life style, especially during this pandemic. It is important to specify and improve awareness on the zero waste topic (Coskun, 2021). Various teaching strategies are used to raise individuals' awareness of the environment and its problems, such as cooperative learning, project-based learning, drama, problem-based learning, and observation (Aysu, 2019; Badem, 2010; Dadli, 2017; Guven & Aydogdu, 2012, Solmaz, 2010). Another strategy that can be used to raise awareness of the zero-waste concept is educational games.

Educational games are activities aimed at learning through experience and participation, based on specific rules and taking place in a specific time and place. They require attention and intelligence, and can be participated in by learners as a group or individually (Gunes, 2014; Sari, 2011). Educational games are an important part of children's lives (Schumann, 2004). They have several features, including providing active participation, being enjoyable, heartfelt, and having their own integrity. They have an integrity on their own and they are a heartfelt process as they provide children joy and pleasure. They help orient children to social roles, relationships, and their environment, and support their physical, mental, spiritual, affective, and social development. Enjoyment combines with learning, creating a natural atmosphere in which a child can discover their own limits and potential (Piaget, 1962; Rubin, Fein, & Vandenberg, 1983). Games are an indispensable activity for not only children, but also adults and all living creatures, benefitting every age for different purposes and contributing to learning and development (Malta, 2010).

It is known that games are beneficial in education and training settings (Turan, Koklukaya, & Guven Yildirim, 2020). Games are attractive, enjoyable, and motivating, and ensure active participation, which increases learning (Gurbuz, Gulburnu, & Sahin, 2017). When learners incorporate their individual abilities and the subjects they need to learn into games, they use their imaginations and experience positive emotions. Learners who use the trial-and-error method to learn through games become more self-confident and enthusiastic about the process (Yawker, 1999). In his study, Holmes (2012) investigated the effect of educational games on learning science, learners' interests, and attitudes. The study showed that educational games have a positive effect on learning science and learners' attitudes. Liu and Chen (2013) aimed to determine the relationship between educational cards and learning concepts in science courses and the educational benefits of games. They concluded that using cards increases success in science courses and promotes positive attitudes. Similarly, Chen, Wang, and Lin (2015) studied the effect of educational game-supported learning on learning science and increasing the motivation of 7th graders. The study concluded that the educational-game supported learning strategy helps learners to express scientific concepts clearly and carefully, and enhances their motivation towards science courses. Moreover, it is accepted that educational games have a positive effect on creative thinking skills (Bulut, 2015), collaborative working skills (Bressler, 2014), science literacy (Keller, 2012; Rees, 2008), and anxiety levels (Yildiz, Simsek, & Aras, 2017). It is clear that educational games have many advantages.

### **1.2. Purpose of the Study**

In this study, educational games are used to raise awareness among pre-service teachers who will shape our future on the concept of zero waste. From this perspective, the study primarily aims to examine the effects of the originally designed educational games on the levels of Zero Waste awareness of science pre-service teachers and to determine the opinions of the pre-service teachers about the practice process.

## **2. METHODOLOGY**

The specific objective of this study was to determine the effects of originally designed educational games on the Zero Waste awareness levels of science pre-service teachers and to determine the opinions of pre-service teachers about the practice process. A combination of quantitative and qualitative approaches was used in the data analysis.

Mixed-method research can be defined as a combination of both quantitative and qualitative data (Nagy & Biber, 2010). The semi-experimental design with a pre-test and post-test control group was used to collect the quantitative data of the research.

A semi-structured interview technique was used to obtain the qualitative data collected in order to support and explain the results obtained from the quantitative data.

## 2.1. Participants

The participants from whom the data were collected were determined using the convenience sampling method. With convenience sampling, researchers select participants who volunteer and are easy to reach, and who are suitable for the research (Cohen, Manion, & Morrison, 2007; Gravetter & Forzano, 2012). The quantitative data of this research were collected from 40 pre-service teachers selected from two branches studying in the third year of a state university in Turkey in the fall semester of the 2021-2022 academic year. Qualitative data for the study was collected from 20 pre-service teachers in the experimental group.

## 2.2. Data Collection Tool

In this study, both quantitative and qualitative data were collected in accordance with the research purpose. The Zero Waste Awareness Scale, developed by Kayis and Guven Yildirim (2022), was used as a quantitative data collection tool. The scale consists of 27 items and 3 sub-dimensions and was prepared in a 3-point Likert type as “yes”, “no”, and “I have no idea”. During the scale development process, the draft scale was applied to 203 pre-service teachers, and the obtained data were subjected to validity and reliability analysis. The Kaiser-Meyer-Olkin (KMO) value of the scale was calculated as .84, and a significant difference was found in the Bartlett Sphericity test result of the scale ( $p < .05$ ). According to the explanatory factor analysis, the scale explains 42% of the total variance. When examining the results of the explanatory factor analysis, it is seen that the factor loads of 27 items in the scale vary between .33 and .80. The internal consistency coefficient of the scale was found to be Cronbach Alpha .86. The lowest total score that can be obtained from the scale is 0, and the highest total score is 54.

The qualitative data of the study were collected with a semi-structured interview form prepared by the researchers. During the semi-structured interviews, questions about educational games, the practice process, and the evaluation of the activities in the process were asked to the pre-service teachers in the experimental group. In accordance with the research purpose, first of all, a draft interview form consisting of 6 questions was prepared to determine the views of the pre-service teachers on the practice process. Afterwards, the draft form was presented to expert opinions. At this stage, interview forms of 4 researchers who are experts in science education and measurement and evaluation fields were examined. After the feedback from the experts, two questions were combined into a single question, and two other questions were removed from the form. The final form included 3 interview questions. In the study, the following questions were asked to the pre-service teachers;

1. Which game did you enjoy the most during the practice?
2. Which game did you have difficulty playing?
3. How did the educational games you played during the practice benefit you? Please explain.

All the data obtained from the interviews was converted into written text after obtaining consent from the participants. Since the pre-service teachers' own sentences are directly given in the results, each pre-service teacher was assigned a code name.

## 2.3. Collecting Data

In this study, first, experimental (N=20) and control groups (N=20) were determined through unbiased assignment. Then, the Zero Waste Awareness Scale was administered to both groups as a pre-test. During the study, the researchers used original educational games designed for teaching the Zero Waste approach in the experimental group, while the control group used a multimedia-supported question and answer technique. The practice process was completed over a period of 6 weeks (18 class hours). Table 1 provides information about the original educational games used in the experimental group during the practice process, including their aims, materials, and rules.

Table 1.

### *Explanations of the Original Educational Games Used in the Practice Process*

<b>Name of the Game</b>	<b>Aim of the Game</b>	<b>Materials for the Game</b>	<b>Process of the Game</b>
Düşün Net Kağıdı Yok Et (Think Clear, Destroy Paper)	The first step of the Zero-Waste approach is to raise awareness about not creating waste. The game aims to encourage pre-service teachers to complete it in a way that generates the least amount of waste.	Ruler, craft paper of different colours, scissors, pencil, compasses.	<ul style="list-style-type: none"> <li>▪ Students are divided into four groups.</li> <li>▪ The groups assigned to create the shapes are asked to use red for the square, yellow for the rectangle, blue for the circle, green for the parallelogram, and purple for the triangle.</li> <li>▪ The square should have sides of 4 cm, the short side of the rectangle should be 4 cm, the long side should be 6 cm, the circle should have a radius of 4 cm, the short side of the parallelogram should be 5, the long side should be 7 cm, and the triangle should have sides of 4 cm.</li> </ul>

Kullan At'ma (Don't Dispose)	The second step of the Zero-Waste approach is to raise awareness for reuse. With the game, the aim is for pre-service teachers to reuse the waste they created in the previous game and other waste provided by the researcher for further recycling.	Craft papers left over from the previous game, scissors, glue, and waste materials such as straw, glass bottles, string, boxes, plastic bottles, caps, string, packaging waste, and waste boxes, etc.	<ul style="list-style-type: none"> <li>▪ Groups are asked to create at least three of each shape and as many shapes as possible.</li> <li>▪ At the end of the game, the waste produced by each group is measured with precision scales. The group that creates the least waste and the most shapes will be declared the winner.</li> </ul>
Geri Dönüşüm Muhteşem Olacak  (Recycling Will Be Amazing)	With the game, the aim is to separate waste according its colour and material, and send it for recycling correctly.	Food waste, electronic waste, glass waste, plastic waste, metal waste, paper waste, non-recyclable waste, coloured recycling bins (paper, plastic, glass, metal, and food), stopwatch.	<ul style="list-style-type: none"> <li>▪ The prerequisite for this game is that the groups use the waste craft paper from the previous game.</li> <li>▪ Students are divided into four groups as heterogeneously as possible, taking into account the class size.</li> <li>▪ Each group is asked to choose one of the secondary school learning outcomes in the Science Education Programme.</li> <li>▪ All groups are asked to develop a teaching material for the outcome they have chosen, provided that they use the waste craft papers from the previous game.</li> <li>▪ At the end of the game, the groups present the materials they have created to the other groups.</li> <li>▪ The pre-service teachers in the other groups are asked to evaluate the presented material using the material evaluation rubric developed by the researcher.</li> <li>▪ The data obtained from the rubrics is analysed, and the group that ranks first is decided.</li> </ul>
Atıksız Bir Evren Hayal mi?  (Wasteless Dream Universe)	The aim of this game is for the groups to prepare the most effective poster for the Zero-Waste approach, taking into account the knowledge and attitudes they learned in the other three games.	This game will use materials left over from previous games (such as pipette, a bottle, a balloon, craft paper, etc.)	<ul style="list-style-type: none"> <li>▪ Students are divided into four groups as heterogeneously as possible, taking into account the class size.</li> <li>▪ Four bags are prepared to contain equal number, quantity, and type of waste. The bags are given to the groups.</li> <li>▪ Each group starts the game at the same time. The groups are asked to sort the garbage into the recycling bin as quickly as possible.</li> <li>▪ Groups receive one point for each correct piece of garbage.</li> <li>▪ The group that separates the garbage in the shortest time and in the most correct way will be the winner.</li> </ul>

The visuals of the pre-service teachers in the experimental group regarding the game-playing process are shown below (Figure 1).

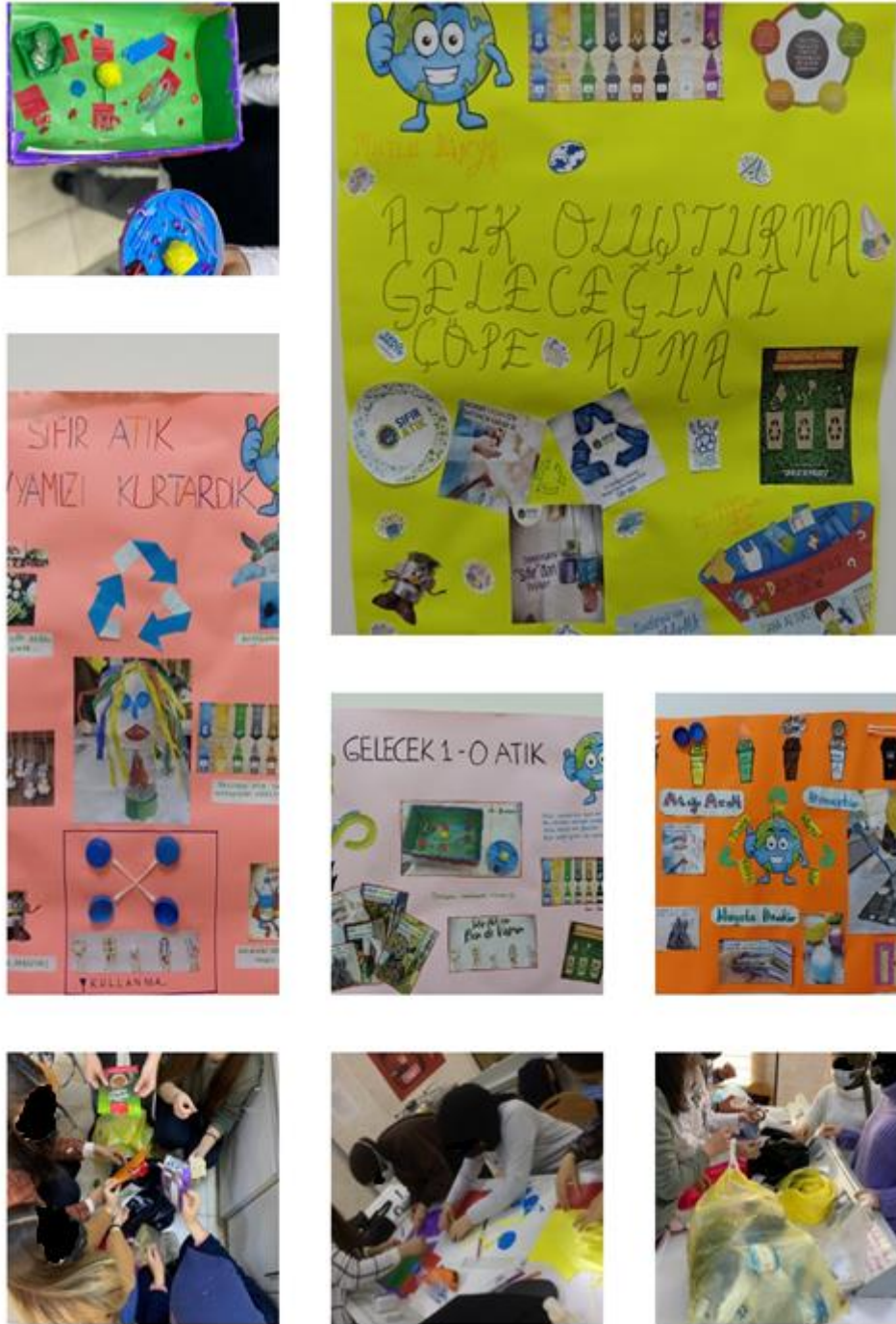


Figure 1. Images of the practice process

After the practice process is completed, the Zero-Waste Awareness Scale is administered to both groups as a post-test. Once the quantitative data of the study was obtained, semi-structured interviews were conducted with the pre-service teachers in the experimental group, and the data gathering process of the study was concluded.

#### 2.4. Data Analysis

The quantitative data from the research was analyzed using SPSS 25. The Shapiro Wilk test was used to determine whether students' responses to the scale were normally distributed. The independent sample *t*-test was used to determine whether there was a significant difference between the pre- and post-test mean scores of the pre-service teachers in different groups. A significance level of .05 was accepted as in all analyses used in the study.

Content analysis, one of the qualitative analysis techniques, was used to analyze the qualitative data obtained from the research. The stages specified by Miles and Huberman (1994) were followed in the analysis of qualitative data. As a first step in qualitative data analysis, the data was converted into written documents. A coding key was created for the data that was turned into a written document, and the statements containing the codes were grouped according to their similarities and differences and turned into themes. After the themes were obtained, tables were created that included the themes, codes, and the frequency of pre-service teachers uttering the codes. Findings were presented to students by giving code names.



### 3. FINDINGS

#### 3.1. Findings of Quantitative Data

In this study, the statistical method to be applied to the data obtained from the awareness scale was initially determined. Quantitative research uses both parametric and non-parametric statistical analysis methods. For parametric analysis methods to be used, the data collected from the participants after the test or scale should exhibit a normal distribution (Cepni, 2007; Sim & Wright, 2002). The Shapiro-Wilk test was applied to all data obtained from the Zero Waste Awareness Scale, which was also used as a data collection tool in this study. The Shapiro-Wilk test is generally preferred when the number of participants is less than 50 ( $n < 50$ ) (Ghasemi & Zahediasl, 2012). The Shapiro-Wilk test results of the study group's Zero Waste Awareness Scale scores are given in Table 2.

Table 2.  
*Shapiro-Wilk Test Results*

Variable	Group	Statistics	df	p
Pre-test	Experimental	.92	20	.11
	Control	.93	20	.17
Post- test	Experimental	.95	20	.45
	Control	.92	30	.11

When examining the results of the Shapiro-Wilk test in Table 2 are examined, it can be seen that the significance level of the scores on the Zero Waste Awareness Scale is greater than  $p > .05$ . The obtained p-values show that the scale scores exhibit a normal distribution according to the variables of pre and post-test scores. Parametric tests were used to analyze the data obtained from the Zero Waste Awareness Scale due to the normal distribution of the data obtained from the scale in terms of all variables. After the data showed normal distribution, an independent sample *t*-test was used to determine whether there was a significant difference between the pre-test mean scores of the Zero Waste Awareness Scale for the pre-service teachers in the experimental and control groups. The results obtained are given in Table 3.

Table 3.  
*Independent Groups t-test Results Regarding Awareness Scale Pretest Scores*

Group	N	$\bar{X}$	Sd	t	p
Experimental	20	22.70	1.59	2.17	.05
Control	20	21.60	1.85		

When examining Table 3, the Zero Waste Awareness Scale score of the pre-service science teachers in the experimental group was  $\bar{X}_{(EG-pretest)} = 22.70$ , and the control group was  $\bar{X}_{(CG-pretest)} = 21.60$ . There was no significant difference between the pre-test achievement scores of the pre-service science teachers in the experimental and control groups ( $t = 2.17, p > .05$ ).

The post-test awareness mean scores of the pre-service science teachers in the experimental and control groups were examined to determine if there was a significant difference. The results of the independent groups *t*-test applied to the post-test scores of the groups are given in Table 4.

Table 4.  
*Independent Groups t-test Results Regarding Awareness Scale Posttest Scores*

Group	N	$\bar{X}$	Sd	t	p
Experimental	20	42.95	1.64	22.13	.00
Control	20	31.95	1.50		

When the data in Table 4 is analyzed, the post-test mean score of the Zero-Waste Awareness Scale for pre-service science teachers in the experimental group was found to be  $\bar{X}_{(EG-posttest)} = 42.95$ , while the post-test mean score of the same scale for pre-service science teachers in the control group was  $\bar{X}_{(CG-posttest)} = 31.95$ . There is a statistically significant difference between the Zero-Waste Awareness Scale scores of the pre-service science teachers in the experimental and control groups after the study, in favor of the experimental group ( $t = 22.13, p < .05$ ).

#### 3.2. Findings of Qualitative Data

The qualitative data from the study was collected using a semi-structured interview technique. The interviews were conducted with 20 pre-service teachers in the experimental group to explain, make sense of, and support the findings obtained from the quantitative data. First, the question "Which of the games you played during the practice did you like the most?" was posed. The code frequency distribution table of the pre-service teachers' answers to the question is given below (Table 5).

Table 5.

*The Most Popular Game During the Practice*

Question	Game	Reason	f	
Which game did you enjoy the most during the practice?	Düşün, Net, Kağıdı Yok Et (Think Clear, Destroy Paper)	Materiality	1	
		Amusingness	6	
	Kullan At'ma (Don't Dispose)	Creating a 3D product	3	
		Setting a good example	3	
		Providing an embodiment	3	
		Providing a reinforcement	3	
		Pragmatic	3	
		Acquiring designing skills	2	
	Geri Dönüşüm Muhteşem Olacak (Recycling Will Be Amazing)	Endowing permanence	2	
		Attractiveness	1	
		Providing daily-life experience	2	
		Pragmatic	2	
		Amusingness	1	
		Raising awareness	1	
		Atıksız Bir Evren Hayal mi? (Wasteless Dream Universe)	Amusingness	4
			Consolidating what has been learnt	3
Enabling Learning	2			
Excogitative	2			
	Providing a reinforcement	2		
	Conveying the theoretical findings into practice	2		
	Providing the opportunity to showcase the product	1		
		Raising awareness	1	

While it was observed that the most favored game among pre-service teachers was "Kullan At'ma" (f=8), the game they liked the least was "Düşün Net Kağıdı Yok Et" (n=1). Only one pre-service teacher expressed an opinion about the importance of the the "Düşün Net Kağıdı Yok Et" game. Regarding the "Kullan At'ma" game, it was observed that the pre-service teachers frequently repeated codes they found amusing (n=6), created a three-dimensional product (n=3), set a good example (n=3), embodied (n=3), and were provided with reinforcement (n=3). In "Geri Dönüşüm Muhteşem Olacak", the codes of providing daily life experience (n=2) and pragmatic (n=2) were frequently repeated. Finally, "Atıksız Bir Evren Hayal mi?", codes such as amusingness (n=4), consolidating what has been learnt (n=3), enabling learning (n=2), and being excogitative (n=2) were repeated by the pre-service teachers. Some of the answers given by the pre-service teachers to the question are given below:

*Ege: "I loved the game "Kullan At'ma". We chose an achievement from the science curriculum and prepared a model from the waste materials we had. I think we made the subject understandable and memorable for both us and the students."*

*Venus: "My favorite game during the application was: "Geri Dönüşüm Muhteşem Olacak". I used to see these boxes in big markets and shopping malls in my daily life, but I didn't know which box some items would go to. Thanks to this game, I learned exactly which items I can throw in the boxes that I come across in my daily life."*

*Alperen: "My favorite part was making course materials suitable for our achievements from waste materials. It was very enjoyable, and I think it is a good example of upcycling and Zero-Waste practices for students as well."*

This time, the pre-service teachers, who stated that they liked the "Kullan At'ma" game more were asked the question, "Which game did you have difficulty playing?". The frequency distribution table of the pre-service teachers' answers to the question is given below (Table 6).

Table 6.

*Games That Were Difficult During Practice*

Question	Game	Reason	f
Which game did you have difficulty playing?	Düşün, Net, Kâğıdı Yok Et (Think Clear, Destroy Paper)	Time constraints	6
		Get bored of the game	3
		Being unable to comprehend its logic	3
		Resulting in indecisiveness	3
		Not knowing waste treatment	2
		Lack of experience	1
		Experiencing a lack of knowledge	1
		Having issues communicating with the group	1
		Facing challenges in psychomotor skills	1

Kullan At'ma (Don't Dispose)	Having trouble envisioning ideas	3
	Lack of creativity skills	2
	Difficulty in choosing recycling materials	2
Geri Dönüşüm Muhteşem Olacak (Recycling Will Be Amazing)	Experiencing a lack of knowledge	2
	Getting bored of the game	1
Atıksız Bir Evren Hayal mi? (Wasteless Dream Universe)	Time constraints	1
	Reflecting the entire process in the design	1
	Difficulty creating banners	1
	Lack of design skills	1

The pre-service teachers who had the most difficulty in the first game frequently stated that they had time constraints ( $n=6$ ), got bored ( $n=3$ ), and were unable to comprehend its logic ( $n=3$ ). In the second game, they had trouble envisioning ideas ( $n=3$ ). Those who complained about the lack of knowledge in the third game ( $n=2$ ) also had difficulties in the last game ( $n=1$ ), reflecting the entire design process ( $n=1$ ) and their lack of design skills ( $n=1$ ). Some of the answers given by the pre-service teachers regarding this question are given below:

*Seymen: "I had the most difficulty in "Düşün Net Kağıdı Yok Et" because I had a hard time in this game because I do not have much knowledge and experience in my daily life to evaluate the things that can create waste and increase the product correctly."*

*Toprak: "I had a hard time in the activity where we did upcycling with waste. After we came up with an idea and put it into practice, it made us a little tired to think about what we could do with which waste."*

*Berkay: "We had a hard time in the game "Geri Dönüşüm Muhteşem Olacak" because we did not have enough information while separating the waste. However, the scoring part of the game was very instructive and memorable in that respect."*

*Serhan: "I had difficulty with the poster game. It was difficult to show the entire process in one conclusion. We tried to include many things in our poster and had to think about the design. Although it was difficult, we successfully completed it."*

The pre-service teachers reported having the most difficulty with the first game. It was determined that their responses to the question were consisted with their responses to the previous question.

Finally, the pre-service teachers were asked, "How did the educational games you played during the practice benefit you? Please explain." The frequency distribution table of their responses is given below (Table 7).

Table 7.  
Contribution of Educational Games to Pre-service Teachers

Question	Theme	Code	f
How did the educational games you played during the practice benefit you? Please explain."	Cognitive	Understanding recycling	7
		Apprehending zero-waste	7
		Obtaining knowledge of waste classification	4
		Developing consciousness	3
		Apprehending upcycling	3
		Learning environmental issues in the curriculum	1
		Quick-thinking skills	1
	Affective	Cooperative learning	4
		Developing sensitivity towards living beings and environment	3
		Socialization	2
		Building interest	2
		A positive attitude/Maintaining a positive attitude?	1
		Caring for future generations	1
		Psychomotor	Developing dexterity
	Gaining designing skills		8
	Acquiring the skill of creating 3D products		7
Employing what has been learned in daily life	3		
		Time management skill	1

Pre-service teachers stated that they had a cognitive understanding of recycling ( $n=7$ ), apprehension about Zero-Waste ( $n=7$ ), and knowledge of waste classification ( $n=4$ ). The contributions of affective-based games such as cooperative learning ( $n=4$ ), gaining sensitivity towards living beings and the environment ( $n=3$ ), socialization ( $n=2$ ), building interest ( $n=2$ ), and positive



attitude attainment ( $n=1$ ), have been observed. As for psychomotor skills, the pre-service teachers frequently repeated that they acquired dexterity skills ( $n=14$ ), gained design skills ( $n=8$ ), and created 3-dimensional products ( $n=7$ ). Some of the pre-service teachers' responses to the question are given below.

*Ege: "I became aware of the subjects in our curriculum and our achievements in secondary school, especially the concepts of zero-waste and recycling. Emotionally, thanks to group work, I had more interaction and communication with my friends. Regarding the psychomotor, I can say that it covers the production stages of all the activities we plan. I can give examples of skills such as cutting paper, gluing, designing, and envisioning ideas.*

*Gediz: "It contributed to raising awareness for protecting and enhancing the nature. I learned about things that harm living things and the environment. It has contributed to mindfulness and awareness of leaving a better world for future generations. Making models, preparing posters, and cutting papers also contributed to my psychomotor skills."*

#### 4. RESULTS, DISCUSSION AND RECOMMENDATIONS

In this study, the aim is to investigate the effect of authentic educational games on the level of zero waste awareness among science pre-service teachers and their perception of the practice process. The study observed that there was no statistically significant difference between the pre-test mean scores of the control group and the experimental group regarding zero waste awareness. However, a statistically significant difference in favor of the experimental group was discovered between the post-test mean scores of the awareness scale after the experimental procedure of the pre-service teachers who participated in the experimental and control groups. This result shows that authentic educational games have a positive effect on the zero-waste awareness level of science pre-service teachers. It is believed that this result is due to the fact that pre-service teachers perceive authentic educational games as different and innovative learning environments. Furthermore, it has been widely known for years that games provide individuals with opportunities to carry out mental exercises, improve their thinking and awareness skills, and make them active in the critical assessment and problem solving process (Sel, 1987).

Upon reviewing national and international literature on the topic, no studies were found regarding the use of educational games to teach zero waste awareness. Moreover, it is clear that there are a limited number of studies on the zero-waste approach in higher education (Aksan & Celikler, 2018; Choiriyah, 2017; Haksevenler, Kavak, & Akpınar, 2021; Harman & Yenikalayci, 2020). Most zero waste investigations conducted in our country focus on issues such as waste management in education, waste minimization, waste recovery systems, waste collection, transportation, and recycling costs (Baykara Mat & Baykal, 2020). However, there are studies investigating the effects of educational games on environmental issues and raising awareness of waste and recycling topics. For instance, Altunbey (2022) conducted a study on the influence of educational games on the 'Residential Waste and Recycling' subject. At the end of the study, it was understood that educational games positively affect awareness in teaching related subjects. In a study conducted by Akbayrak and Kuru Turasli (2017), learning exercises, which includes educational games, were analyzed for their impact on environmental awareness, and it was shown that these games have a positive impact on environmental awareness. In one more study, implemented by Kirmiziyüz, Ercan and Uz Bilgin (2021), a digital, educational game was designed, applied, and its influence was assessed on the 'Transformation of Electric Energy and Recycling' subject. At the end of the application process, the learners' views on the game are revealed that they found the game entertaining and useful for teaching this content. Similarly, in a variety of studies conducted with different age groups in different countries in recent years, it has emerged that educational games have a positive influence on knowledge, attitude, and awareness of recycling and waste separation (Chin & Wahid, 2020; Chow, Cheung, & Yeung, 2017; Gaggi, Meneghello, Palazzi, & Pante 2020; Gizzi, Di Dio, & Schillaci, 2019; Miller, Wentzel, Clark, & Hurst, 2019; Rodrigues & Bruno, 2020; Satria, Fitriani, Muhsin, & Tresnawati, 2020).

The qualitative data from the study was collected through three open-ended questions asked to pre-service teachers. The first question posed was "Which game did you enjoy the most during the practice?". When examining the answers given by the candidates, it was found that they stated they enjoyed the "Kullan Atma" game the most in terms of frequency. However, it was noticed that only one pre-service teacher stated that he enjoyed the game "Düşün, Net, Kağıdı Yok Et". In Altunbey's (2022) study, it was seen that the students mostly evaluated plastic waste during the application, in line with the result of this question. Similarly, in Aksan's (2016) research, it was found that science pre-service teachers mostly included the evaluation of plastic waste in the models they created. When examining the answers given to the question, it was seen that the candidates reported reasons such as being fun, creating a 3-dimensional product, creating a good example, providing concretization, being instructive, providing reinforcement, acquiring design skills, maintaining permanence, and attracting attention as reasons for liking this game. When looking at the literature, similar to the answers given by the pre-service teachers, educational games combine fun and educational elements (Al Azawi, Al-Faliti, & Al-Blushi 2016), change the learning quality by switching learners from passive learning to active learning (Song & Zhang, 2008), ensure the permanence of the learned information (Babaandac, 2013), make learning enjoyable and fun (Turan, Koklukaya, & Guven Yildirim, 2020; Karamustafaoglu & Kaya, 2013), increase interest in the lesson (Can & Yildirim, 2017), and ensure active participation in the learning process physically and mentally (Yenice, Alpak Tunc, & Yavasoglu, 2019).

In the second question, "Which game did you have difficulty playing?" it was found that the answers given had great consistency with the answers to the first question. Pre-service teachers stated that they had the most difficulty in the game "Düşün, Net,

Kağıdı Yok Et". In the previous question, it was remarkable that only one pre-service teacher stated that he liked this game. Pre-service teachers stated that they had difficulties in this game due to reasons such as experiencing time problems, getting bored with the game, not understanding the logic of the game, causing indecision, having difficulties in psychomotor skills, not knowing how to evaluate waste, being inexperienced, having a lack of knowledge, and having communication problems with the group. When examining studies on the subject, results of the studies stating that educational games may have some limitations were found. Researchers also stated that educational games may take longer than expected and the game may be interrupted due to lack of time (McFarlane, Sparrowhawk, & Heald, 2002), and that some students may not participate in the games due to physical or mental factors (Karamustafaoglu & Kaya, 2013).

Finally, the pre-service teachers were asked, "How did the educational games you played during the practice benefit you? Please explain." The question revealed that the candidates' answers could be grouped under three themes: cognitive, affective and psychomotor skills. This result is consisted with Altunbey' (2022) research, which emphasized that teaching with educational games was effective in developing cognitive, affective, and psychomotor domains. Similarly,, Kilic and Karamustafaoglu's (2020) study found that teachers believed educational games were effective in developing cognitive and affective skills in students. Burgaz Uskan and Bozkus's (2019) study also showed that educational games engage all senses of students, allowing them to internalize knowledge, skills, and behaviors and achieve permanent learning.

The zero waste approach is an approach that should be adopted immediately to ensure that the world we live in remains livable. Every individual is influenced by their teachers, regardless of their future occupation. Therefore, it is extremely important for pre-service teachers to learn what Zero Waste approach and gain awareness about it before they start working. The results of this study indicate that educational games can positively increase awareness of the zero-waste approach. This study sheds new light on alternative studies, learners can gain enlightenment, attitude, awareness, and even some behaviors through various learning methods and techniques, or realias. Furthermore, by repeating the application in different age groups, students at all educational levels can experience learning through educational games.

### Research and Publication Ethics Statement

The purposes and procedures of the current study were granted approval from the ethical committee of the Gazi University (03.01.2022 / E-77082166-302.08.01- 253769).

### Contribution Rates of Authors to the Article

All authors contributed equally to this article.

### Statement of Interest

The authors have no conflict of interest.

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