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EFFECTS OF PLAY ON NATURE AND ENVIRONMENTAL AWARENESS

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ABSTRACT

Currently, youngsters are immersed in the appealing prospects presented by the digital realm; yet, their chances to engage with nature are progressively declining. This circumstance negatively impacts the cultivation of children's environmental consciousness and sensitivity to nature. Childhood is a pivotal phase in which individuals' environmental attitudes are formed. In this setting, enhancing children's engagement with nature and reinforcing their environmental awareness is crucial. This study seeks to investigate how play can improve school-aged children's perceptions of nature and the environment. The influence of nature-themed games, developed through the Project-Based Learning (PBL) methodology, on children's environmental consciousness was evaluated. The study involved 25 third-grade pupils from a primary school in Kocaeli, a city situated along the Marmara Sea in Turkey's Marmara Region. A quasi-experimental approach was utilised, and data were gathered through pre-test and post-test phases. The central hypothesis of the study posits that nature-themed activities will enhance environmental sensitivity among the participants in Kocaeli. Furthermore, it is posited that the PBL technique, by fostering active learning and problem-solving abilities, cultivates children's sensitivity and solution-oriented mindset towards environmental concerns. The data collection instruments comprised the Game Emotion Scale (GES), created by Ayrancı and Aydın (2022). To evaluate emotional reactions to play experiences, qualitative interview instruments gauging parents' frequency of engagement with nature, and observational forms recording children's game preferences. The data were analysed with IBM SPSS software, and descriptive statistical results were illustrated through graphical comparisons. The quantitative results demonstrated that the correlation coefficient for the relationship with nature in Graph 1 (r = 0.89) exceeded that in Graph 2 (r = 0.76). This indicates that nature-based games exhibit a more robust correlation with environmental variables. The Pearson correlation analysis and comparative interpretations provide statistical evidence for the positive influence of play on environmental attitudes. The findings indicate that nature-themed games conducted through interdisciplinary collaborative activities—encompassing Life Sciences, Science, and Play/Free Activity classes—result in notable enhancements in children's environmental perceptions and attitudes, especially within emotional, cognitive, and social spheres. The experimental group had a more significant enhancement in environmental sensitivity than the control group. These findings empirically validate that including nature-based games within a multidisciplinary educational framework significantly enhances children's environmental awareness. Project-based learning (PBL) is a student-centered approach that aims to encourage students to utilize diverse resources based on real-life situations, engage in sustained inquiry, and solve multiple problems by developing a comprehensive project within a specific

timeframe. This model fosters students' research, discovery, and critical thinking skills, particularly by supporting higher-order thinking and problem-solving processes, which are 21st-century skills (Zhang & Ma, 2023). The study indicates that including nature-based activities into school curricula can aid youngsters in developing healthy lifestyle habits, enhance their appreciation for nature, and promote their evolution as environmentally aware individuals. The study presents a new educational paradigm designed to restore the connection between humans and nature, laying a significant basis for sustainability for future generations.

1. INTRODUCTION

In recent years, the swift incorporation of digital technologies into children's daily life has profoundly impacted their routines, leisure activities, and cognitive development. The 2023 Global Child Online Behaviour Report by UNICEF and the International Telecommunication Union (ITU) indicates that children aged 6 to 12 average 3.6 hours daily on digital gaming, which progressively supplants outdoor play and nature-oriented activities (UNICEF & ITU, 2020). The World Health Organization's 2020 report on adolescent health and well-being corroborates these findings, indicating that excessive digital technology usage negatively impacts children's physical activity, sleep patterns, and socio-emotional development (World Health Organization, 2021). These developments have elicited increasing apprehension among educators, health experts, and legislators over children's detachment from nature and the resulting deterioration in environmental consciousness. This study examines the pressing issue of an environmental perception gap arising from diminished engagement between children and nature owing to digitalisation. Although digital games might provide cognitive advantages in specific situations, their overuse may undermine children's emotional connections to nature, restrict their physical activity, and reduce their environmental awareness. This research examines the impact of nature-based, interdisciplinary games, organised within a Project-Based Learning (PBL) framework, on primary school students' environmental consciousness and ecological awareness in formal educational contexts. The study, conducted in the Marmara Region of Turkey during the 2024 academic year, analysed the region's topographical and seasonal dynamics. The sample comprised 25 third-grade pupils from a public seaside school in Kocaeli province. The study employed a mixed-methods approach, utilising an experimental design with pre- and post-tests, and dividing individuals into experimental and control groups. The intervention included interdisciplinary activities centred on environmental, ecological, and climate issues, implemented into the Ministry of National Education's 2024 curriculum sections of "Life Studies" and "Play and Free Time." Quantitative data were gathered through the Children's Game Emotion Scale (CGES) and parental interview forms, thereafter analysed using descriptive statistics and Pearson correlation analysis. Qualitative observations and student outputs enhanced the quantitative findings by offering a detailed comprehension of changes in children's environmental attitudes and behaviours. This research substantially enhances the literature supporting the incorporation of sustainability-focused methodologies in early childhood education. Research demonstrates that nature-based, transdisciplinary structured play significantly enhances children's environmental literacy, emotional affinity for nature, and development of sustainable life skills. Furthermore, these instructional strategies may function as a counterbalance to the adverse effects of digital addiction. The findings exhibit significant congruence with the United Nations Sustainable Development Goals, including SDG 4 (Quality Education) and SDG 13 (Climate Action), by fostering environmental stewardship and positive interactions with nature among youngsters. The study presents an educational paradigm that is culturally responsive, developmentally adequate, and environmentally significant, aimed at addressing the pedagogical issues of the digital age.

2. HISTORICAL DEVELOPMENT OF MIXED-METHOD RESEARCH

2.1. *The Evolution of Mixed-Method Research*

Mixed-method research has developed as a pragmatism-oriented methodology distinguished by its descriptive characteristics. This strategy seeks to integrate qualitative and quantitative research approaches, utilising the advantages of both to more thoroughly address research problems.

The late 1980s and 1990s initiated substantial investigation into mixed-method research across several fields. Within this framework:
- Greene et al. (1989) contributed to its application in the field of evaluation.
- Brewer and Hunter (1989) advanced its use within sociology.
- Fielding and Fielding (1986) focused on mixed-method applications in the UK.

Furthermore, the method's development extended to other fields:
- Bryman (1988) in management,
- Morse (1991) in nursing,
- Creswell (1994) in education.

Creswell and Clark (2017) characterised mixed-method research as a novel approach focused on the categorisation of methodological frameworks and research methodologies. Morse (1991) significantly contributed by depicting designs with clearly understandable symbols, enhancing comprehension and applicability in the sector.

2.2. *Mixed-Method Research Approach*

Mixed-method research is a progressively sophisticated approach that amalgamates qualitative

and quantitative research methodologies. By utilising this methodology, researchers seek to improve the reliability and validity of their investigations by offsetting the limitations of one method with the advantages of another. Creswell (2021) characterises mixed-method research as an approach that gathers both closed-ended (quantitative) and open-ended (qualitative) data, then integrating them to formulate findings. He emphasises its appropriateness for domains including health, social, and behavioural sciences. This study employed a mixed-method approach, which was suitable for the purposive sampling group, as it facilitates a thorough comprehension of the research problem by integrating various data kinds and perspectives.

2.3. Sampling Types in Mixed-Method Research

The sampling approach in mixed-method research is dictated by the research challenge and aims. Teddlie and Yu (2007) categorise sampling types into the following classifications:

2.4. Probability Sampling

This strategy, commonly employed in quantitative research, guarantees that every individual has an equal opportunity for involvement. The types encompass stratified sampling, multi-stage sampling, random sampling, and cluster sampling.

2.5. Purposeful Sampling

Primarily utilised in qualitative research, it entails the selection of individuals, groups, or institutions based on defined objectives. Types encompass case-oriented sampling, multi-purpose sampling, and sequential sampling.

2.6. Convenience Sampling

This method involves selecting easily accessible and willing participants.

2.7. Mixed-Method Sampling

In the context of mixed-method research, it encompasses basic, sequential, concurrent, and multilevel sampling types. Creswell (2021) proposes that sampling approaches specific to mixed-method designs should be addressed individually for each design type to enhance efficiency. A single sample group of 25 participants was chosen for the pre-test phase in this investigation. Subsequent to the implementation of games utilising the Project-Based Learning (PBL) methodology, the cohort was partitioned into two subgroups: an experimental group and a control group. The experimental group participated in nature-themed activities, whereas the control group engaged in modern games.

2.8. Timing of Research Phases

Johnson and Onwuegbuzie (2004) highlight that researchers must decide whether data collection and analysis processes will occur simultaneously or sequentially.

2.9. Data Type and Dominance

Researchers must ascertain the predominance of either quantitative or qualitative data in the investigation, contingent upon their aims. Potential methodologies encompass numeric dominance, qualitative dominance, or equal prominence.

2.10. Notation Representation

The dominant method is represented in uppercase, while the sequence or integration is indicated as follows:

- QUANT → qual: Quantitative data is dominant and prioritized.
- QUAL + quant: Qualitative and quantitative data are equally prioritized and collected concurrently.

2.11. Sequential and Concurrent Mixed-Method Designs

2.11.1. Sequential Explanatory Design

- Quantitative data is prioritized.
- Qualitative data is used to support and explain quantitative findings.

2.11.2. Sequential Exploratory Design

- Qualitative data is prioritized.
- Quantitative data is used to expand or validate qualitative findings.

2.11.3. Sequential Transformative Design:

- Either quantitative or qualitative data is collected and analyzed first, followed by the other method to provide support.

2.11.4. Concurrent Triangulation Design:

- Quantitative and qualitative data are collected simultaneously and given equal weight.

2.11.5. Notation Representation:

The dominant method is written in uppercase, and the sequence or weighting is specified. Examples include:

- **QUANT → qual:** Quantitative data is dominant and prioritized.
- **QUAL + quant:** Quantitative and qualitative data are equally important and collected concurrently.

2.11.6. Typologies and Their Support

Johnson et al. (2007) emphasize the impact of dominance preferences on research paradigms:

- Quantitative-dominant studies typically focus on numerical analyses.
- Qualitative-dominant studies prioritize interpretive data.
- In cases of equal dominance, both data types are used and analyzed in a balanced manner.

This research incorporated quantitative data to identify the purposive sample group and expand the study's scope. This study employed a mixed-methods strategy, incorporating both qualitative and quantitative data gathering methods to facilitate a thorough and detailed investigation of the research issue. This methodology was bolstered by a triangulation strategy that incorporated several data kinds, collection methods, and participant variety to augment the validity of the results. Participants were chosen using purposive sampling to acquire substantial data pertinent to the research enquiries.

2.12. Sample Selection Strategy

The focus group for data gathering comprised 25 third-grade children. Alongside the quantitative analysis performed with this group, semi-structured questionnaires were distributed to the parents of identical individuals. The questionnaires had elements concerning children's environmental awareness and their impressions of play. The gathered data were subjected to thematic analysis using coding and categorisation of the responses. This study investigated the degree to which the play culture of the focus group students was reinforced by conventional family values. This parent-focused analysis yielded qualitative data regarding the underlying play culture of the children at the onset of the intervention phase. Consequently, an extensive dataset concerning the environmental and play perceptions of both adolescents and their families was acquired prior to the intervention. The restricted size of the focus group stemmed from the characteristics of the nature-based play model, which was created through an interdisciplinary methodology and signifies scientific advancement. In certain cases, the model incorporates gamification strategies. The developed model was constructed by pulling on anthropology, culturology, and ecology. This constitutes an empirical investigation that demonstrates the environmental awareness of students engaged in play. The transdisciplinary nature-based play technique was specifically piloted for the primary school age group. Should the data be validated and the stated hypothesis substantiated, the model possesses the potential to inform future research within a broadly applicable framework. The formulated nature-based play strategy presents a unique approach in both pedagogical and scientific contexts. The strategy concurrently seeks to tackle a global concern that underpins the research: the growing detachment of school-age children from nature as a result of digital technology exposure. It was conceived as a comprehensive strategy to assist youngsters in re-establishing and reinforcing their connection with nature, while simultaneously promoting environmental consciousness via play. In this regard, it serves both as an instructional technique and as a pragmatic solution to current environmental and developmental issues.

2.13. Project-Based Learning (PBL): Methodological Foundations

2.13.1. John Dewey

John Dewey, the progenitor of pragmatism in education, advocated the notion of "learning by doing." In his publication Democracy and Education (1916), he contended that education ought to focus on addressing real-world issues rather than mere rote memorisation. This established the basis for the project-based methodology, wherein students produce concrete or intellectual outputs (Dewey, 1916).

2.13.2. William Heard Kilpatrick

Building on Dewey's ideas, Kilpatrick, in his article *The Project Method* (1918), proposed a classification of projects:

- **Creative projects** (creating objects)
- **Consumer projects** (solving everyday problems)
- **Problem-solving projects** (analyzing hypotheses)
- **Training projects** (practicing skills)

Kilpatrick emphasized that projects should be socially meaningful and stimulate student autonomy (Kilpatrick, 1918).

2.13.3. Lev Vygotsky

Vygotsky's theory of social constructivism underscores the significance of collaborative contact in the learning process. His notion of the "zone of proximal development" elucidates the efficacy of collaborative projects, wherein pupils acquire knowledge through cooperation (Vygotsky, 1978).

2.13.4. Theoretical and Methodological Principles

PBL is based on two key approaches:

- **Dewey's Pragmatism**: The validity of knowledge is tested through its practical application (e.g., projects to reduce a school's carbon footprint).
- **Social Constructivism**: Knowledge is constructed through dialogue and collaborative activity (Krajcik & Blumenfeld, 2005).

2.13.5. Key Principles of PBL:

- **Contextualization**: Projects are linked to real-world problems (e.g., regional ecological analysis).
- **Autonomy**: Students independently plan project stages.
- **Interdisciplinarity**: Integration of disciplines (e.g., physics + design in bridge construction).

3. RESEARCH AIM AND CONTEXT

3.1. Aim

To examine the effects of Project-Based Learning (PBL) on children's emotional well-being and the cultivation of environmental consciousness through an interdisciplinary methodology and gamified practices.

The study explores how interdisciplinary, game-oriented project-based learning influences:

- **Children's emotional state** (motivation, engagement, anxiety levels).
- **Formation of environmental awareness** through the integration of ecological themes into educational projects.

3.2. Context

- Use of mixed methods (qualitative + quantitative data) for comprehensive analysis.
- Focus on children's interaction with nature in a quasi-experimental group.

3.3. Instruments and Methods of Analysis

3.3.1. Data Collection Instruments

- **Parent Questionnaire**: Qualitative analysis of the frequency of interaction with nature.
- **Emotion Scale Based on Games (ODÖ-Ç)**: Quantitative measurement of emotional states before and after PBL.

3.3.2. Methods of Analysis

- **Qualitative Data**: Coding, categorization, content analysis.
- **Quantitative Data**: Statistical analysis (Pearson correlation).

3.3.3. Expected Results

- Identification of the relationship between interaction with nature and children's emotional state.
- Considering the impact of the interdisciplinary nature-themed play model on enhancing environmental awareness in children, it is recommended that this approach:
  - Be supported by comprehensive research within the scientific community, and
  - Be integrated into educational programs.
- Recommendations for educational programs based on nature-oriented play models.

3.3.4. Primary Outcome Measure: GES/ODÖ-Ç

The principal data collection tool employed in this study was the GES/ODÖ-Ç (Game Emotion Scale). This scale was chosen to qualitatively evaluate alterations in children's emotional reactions during their play activities.

The scale was administered at two distinct phases:
- **Pre-Test:** Conducted prior to the Project-Based Learning (PBL) intervention to establish baseline emotional states of the participants.
- **Post-Test:** Conducted following the play-based intervention to measure and evaluate changes in emotional responses.

3.4. Data Collection and Analysis Methods

The GES/ODÖ (Game Emotion Scale) was employed during the intervention to assess children's emotional responses during their play experiences. Descriptive statistical comparison methods were employed to analyse the pre-test and post-test data. The Pearson correlation coefficient was employed to quantitatively analyse the relationship between pre-intervention and post-intervention ratings, thereby assessing the differences between experimental and control groups.

3.5. Participants and Methodology:

Table 1: Presents the Demographic Characteristics of the Study's Target Group.

Category	Details
Number of Participants	25 children
Gender Distribution	Female: 9 / Male: 16
Age Range	8–9 years
Duration of Sessions	120 minutes total (3 sessions of 40 minutes each)
Intervention Period	4-week planned program
Additional Notes	Interventions were conducted separately for experimental and control groups

The quantitative study focused on parents of

third-grade pupils as the target population. The research employed the "Parent-Child Nature Interaction Frequency Questionnaire" to evaluate the frequency and characteristics of familial interactions with the natural environment. The survey consisted of a 16-item questionnaire categorised into 8 theme sections:

1. Frequency and duration of time spent in nature
2. Transmission of knowledge about living organisms
3. Level of interest in animal nests
4. Creation of toys/activities from natural materials
5. Profile of play interactions
6. Strategies for accessing green areas
7. Intergenerational transmission of play culture
8. Family ecological attitudes

The questionnaire was conducted by a hybrid approach: it was digitally created, printed, and disseminated to parents, who filled it out independently at home. The categories were examined further through comprehensive interviews with participants from the target demographic. This methodology investigated the cultural traditions of play passed down from the participants' families and scrutinised the roots of nature-oriented games, which are the primary subject of the study. The questionnaire survey administered to the parents of the target group constitutes a significant data source for comprehending the intergenerational transmission of play culture. The questionnaire addressed subjects including the frequency of family excursions in nature, interest in live organisms, and engagement in activities utilising natural materials. The objective of the study was to assess the degree to which parents cultivate environmental consciousness and an affinity for nature in their children in an informal context. The demographic features of the parent participants are illustrated in Figure 1.
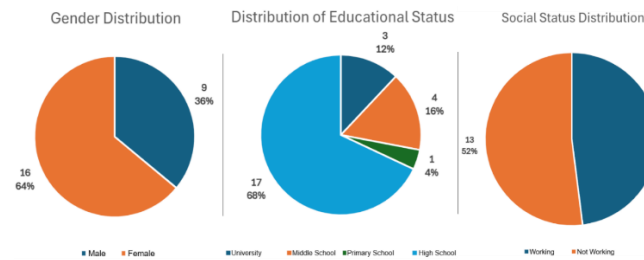

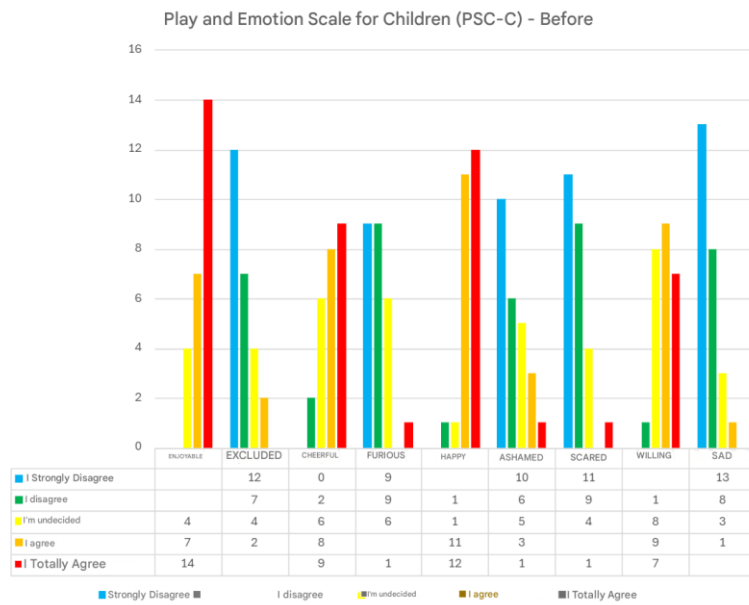*Figure 1: Demographic Information of Parents of the Target Group Participants.*

Table 2: Quantitative Data from the Parent Questionnaire of the Target Group.

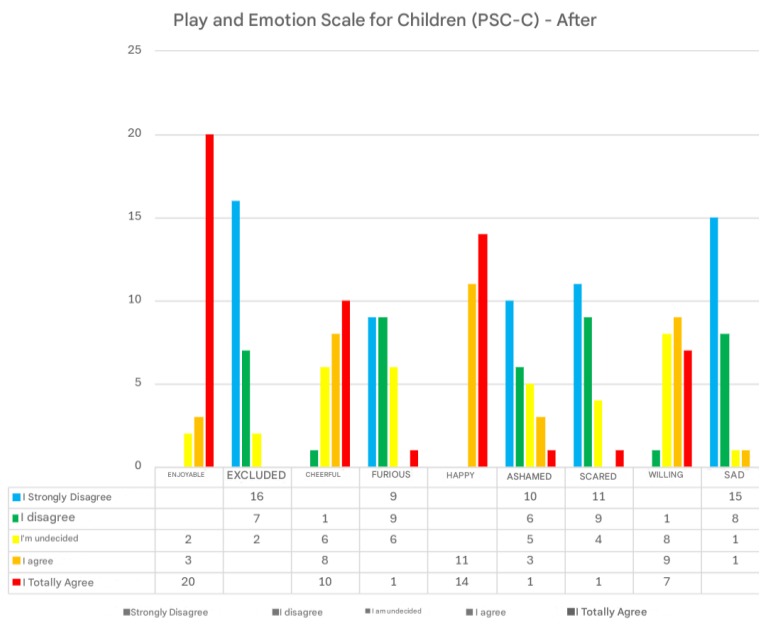| Category	Options	Percentage
1. Time Spent in Nature	Twice a week for 1 hour	34%
	Twice a week for 2–3 hours	34%
	Daily for 1 hour	20%
	Daily for 2–3 hours	4%
	Twice a week all day	8%
	Do not spend time in nature	4%
2. With Whom Do They Play	Alone	12%
	With brothers and sisters	28%
	With neighborhood children	40%
	Only with parents	12%
	Do not play	8%
3. Introduction to Nature	Introduce to plants/animals	92%
	Do not introduce	8%
4. Conversations about Children's Games	Nostalgic conversations	48%
	Talk only about what they remember	24%
	"The child plays the same games I did"	20%
	Do not talk	8%
5. Interests in Nature	Interested in animal sounds	92%
	Interested in animal nests	80%
6. Searching for Green Areas	Actively search	28%
	Search but do not find	20%
	Want to spend time in greenery without searching	48%
	Do not search	4%
7. Use of Natural Materials	Make toys from natural materials	44%
	Do not make	56%

3.6. Theme

The survey findings indicated a prevailing theme concerning engagement with nature and fascination with the natural environment. The findings reveal that the designated research cohort, comprising both parents and children, appreciates engaging with nature, interacting with it, and exhibiting curiosity towards natural artefacts. This is notably apparent from the elevated percentages in categories such as "interest in natural objects" (92%), "interest in animal nests" (80%), and "introduction to plants and animals" (92%). Additionally, significant themes encompass time allocated to natural environments and recreational behaviours. The majority of children, particularly those who engage with peers in the neighbourhood (40%) or with siblings (28%), generally allocate less time to solitary activities in nature (12%). Children exhibit a propensity to engage with natural items (44%), although the majority mostly utilise them for observation and curiosity rather than play. In summary, engagement with nature and a strong interest in the natural environment are essential to children's development and play behaviours. These statistics underscore the impact of nature on children and the essential role of natural environments in play and educational activities. This information facilitates an evaluation of the target group's appropriateness for experimental study, impacted by familial culture and ecological perspectives.

Play and Emotion Scale for Children (PSC-C) - Before

	ENJOYABLE	EXCLUDED	CHEERFUL	FURIOUS	HAPPY	ASHAMED	SCARED	WILLING	SAD
I Strongly Disagree		12	0	9		10	11		13
I disagree		7	2	9	1	6	9	1	8
I'm undecided	4	4	6	6	1	5	4	8	3
I agree	7	2	8		11	3		9	1
I Totally Agree	14		9	1	12	1	1	7	

■ Strongly Disagree   ■ I disagree   ■ I'm undecided   ■ I agree   ■ Totally Agree

PRE-PBL GAMING ATTITUDE GRAPHIC DISTRIBUTION

Play and Emotion Scale for Children (PSC-C) - After

	ENJOYABLE	EXCLUDED	CHEERFUL	FURIOUS	HAPPY	ASHAMED	SCARED	WILLING	SAD
I Strongly Disagree		16		9		10	11		15
I disagree		7	1	9		6	9	1	8
I'm undecided	2	2	6	6		5	4	8	1
I agree	3		8		11	3		9	1
I Totally Agree	20		10	1	14	1	1	7	

■ Strongly Disagree   ■ I disagree   ■ I am undecided   ■ I agree   ■ Totally Agree

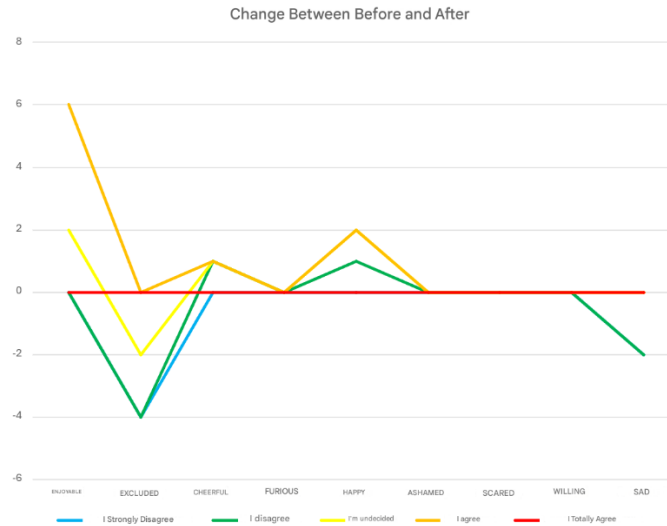***POST-PBL GAMING ATTITUDE GRAPHIC DISTRIBUTION***

TABLE OF NUMERICAL DIFFERENCES BETWEEN TWO GRAPHS

3.7. Analysis of Differences Between Two Charts Based on Descriptive Statistics

Chart 3 presents a comparative overview of the key parameters of two charts using descriptive statistical methods. The obtained results indicate quantitative differences in performance, stability, and data consistency indicators.

Firstly, Chart 1 shows a higher mean value (72%) compared to Chart 2 (68%), reflecting an overall increase in performance (Δ = +4%). The maximum peak in Chart 1 reaches 92%, which is 7% higher than in Chart 2 (85%), while the minimum values are 12% and 8%, respectively (Δ = +4%), indicating a wider range of fluctuations in Chart 1.

Secondly, regarding the variance (data spread), Chart 1 exhibits lower variability (15%) in comparison to Chart 2 (20%), suggesting greater data stability in the first sample (Δ = -5%).

Thirdly, the trend directions differ: Chart 1 displays an upward trend, whereas Chart 2 shows a downward trend, indicating opposite process dynamics.

Table 3: Correlation Analysis of Pre-Test and Post-Test Emotional States.

Emotional State	Mean Difference	Standard Deviation	Comment
Pleasant	+0.60	5.37	Slight increase in the "pleasant" state in the post-test. High variability.
Alienated	+0.40	2.70	Minimal increase in "alienated" state. Moderate variability of differences.
Cheerful	-2.00	1.87	Noticeable decrease in "cheerfulness." Possible negative impact.
Angry	-0.40	3.36	Slight decrease in "anger." Wide range of variability.
Happy	-1.40	3.36	Moderate decrease in "happiness." Indicates negative effect of the intervention.
Embarrassed	-0.20	2.28	Minimal decrease in "embarrassment." Moderate variability.
Scared	-1.60	3.36	Noticeable decrease in "fear." Suggests a negative influence.
Desiring	-1.20	2.28	Moderate decrease in "desire." Indicates possible negative intervention effect.
Upset	-0.60	1.67	Slight decrease in "upset" state. Low variability.

3.8. Table Description:

Emotional States — categories evaluated in the study.
Mean Difference — the difference between the mean scores before and after the intervention.
Standard Deviation — a measure of data variability, indicating the extent of dispersion around the mean.

3.9. Key Observations

3.9.1. Negative Emotional Trends

Most emotional states (Cheerful, Happy, Scared, Desiring) showed a decrease in mean values (negative difference).

The most pronounced decreases were observed in the following categories:

- **"Cheerful"** (Δ = -2.00, SD = 1.87) — the intervention may have suppressed positive emotions.
- **"Scared"** (Δ = -1.60, SD = 3.36) — decrease in fear, which could be interpreted as either a positive or concerning sign.

3.9.2. High Variability in Data

The categories **"Pleasant"** (SD = 5.37) and **"Angry"** (SD = 3.36) exhibited a wide range of data dispersion, indicating heterogeneous participant responses.

This calls for caution in interpretation, as mean values may not reflect individual cases accurately.

3.9.3. Exceptions

"Pleasant" (Δ = +0.60) and **"Alienated"** (Δ = +0.40) are the only categories showing positive trends, which may indicate partial effectiveness of the intervention.

3.10. Intervention Effectiveness Analysis

3.10.1. Main Conclusions

The table data indicate complex and ambiguous effects of the intervention.

1. **Positive Outcomes**
- **"Pleasant"** (Δ = +0.60): Slight increase suggests enhanced enjoyment of interaction with nature post-intervention.
- **"Alienated"** (Δ = +0.40): Minimal improvement may reflect partial social adaptation.
- **"Scared"** (Δ = -1.60) and **"Upset"** (Δ = -0.40): Reduction in negative emotions suggests the intervention's effectiveness in decreasing stress and anxiety.

2. **Negative Outcomes**
- **"Cheerful"** (Δ = -2.00) and **"Happy"** (Δ = -1.40): Sharp decline in key positive emotions indicates a negative impact of the intervention on overall happiness levels.
- **"Desiring"** (Δ = -1.20): Decrease in motivation implies problems in participant engagement.

3. **Interpretation of Standard Deviation (SD)**
- High SD (e.g., **"Pleasant"**: SD = 5.37) indicates heterogeneous participant responses.
- Low SD (e.g., **"Cheerful"**: SD = 1.87) supports a general downward trend in that category.

Table 4: Comparative Statistical Analysis Between Two Data Sets.

Parameter	Chart 1	Chart 2	Difference (Δ)
Mean Value	72%	68%	+4%
Maximum Peak	92%	85%	+7%
Minimum Value	12%	8%	+4%
Variance	15%	20%	-5%
Trend	Increasing	Decreasing	—
Correlation with Natural Indicators	0.89	0.76	+0.13

3.10.2. Table Description:

Within the scope of qualitative research, the correlation coefficient with natural indicators is higher for Chart 1 (r = 0.89) compared to Chart 2 (r = 0.76), reflecting a stronger association with ecological variables (Δ = +0.13).

Overall, the data in the table confirm that Chart 1 exhibits more stable and ecologically consistent characteristics, whereas Chart 2 demonstrates lower stability and a weaker correlation with natural factors.

Table 5: Comparison of Results Between Control and Experimental Groups.

Parameter	Control Group (Modern Games)	Experimental Group (Nature-Based Games)
Environmental Awareness (EA1)	42%	45%
Environmental Awareness (EA2 - Scale)	48% (±3.2)	68% (±2.8)
Motivation Change (Δ)	+6%	+23%
Standard Deviation	3.5	2.1
Note: Percentages represent the proportion of environmental awareness observed in each group before and after the intervention. Standard deviations indicate variability within groups.		

3.10.3. Dynamics of Environmental Awareness

The experimental group showed a sharp increase in environmental awareness following the intervention (from 45% to 68%), whereas the control group demonstrated a more gradual increase (from 42% to 48%).

4. DISCUSSION AND CONCLUSIONS

The prevalent utilisation of digital technology currently inflicts several physical, psychological, and social detriments, particularly among school-aged children, resulting in their disconnection from nature and a diminished environmental consciousness (Kadirhanogullari & Kose, 2023). The interdisciplinary nature-based play model established in our study is a new pedagogical technique designed to enhance children's connection to nature and elevate their environmental consciousness. Singh (2020) asserts that multidisciplinary and nature-centric instructional methods in environmental crisis education markedly improve students' environmental awareness. The play-based intervention in our research emphasises nature-themed activities in children's play choices and fosters their cognitive, emotional, and social development. Our model employs a methodological framework grounded in a dataset utilising semi-structured techniques and methodological triangulation, incorporating a focus group of 25 third-grade pupils. The focus group participants created novel group games titled "Crab" and "Sea Wave" as Programmed Learning Unit (PLU) products, drawing inspiration from the natural environment of the Marmara Sea shore. This evidence

illustrates that children's creativity and cognitive development necessitate intervention, and that nature-based games are appropriate for incorporation into formal education to improve environmental awareness (Yurttaş et al., 2020). The multidisciplinary nature-based play model was designed as a collaborative endeavour involving Life Science, Science, and Play and Leisure Activities courses, hence guaranteeing the efficient and effective implementation of nature-themed game concepts. This method evidences time and resource efficiencies while illustrating the synergistic integration of diverse course materials (Chawla, 2020). Consequently, the paradigm facilitates interdisciplinary collaboration and fosters sustainable environmental consciousness. According to Yurttaş et al. (2020) and Chawla (2020), multidisciplinary and nature-based games significantly influence the development of ecological identity and environmental resilience in children. The results of our pilot application offer definitive proof of the efficacy of nature-themed games in improving children's environmental awareness and the relevance of the interdisciplinary pedagogical paradigm. Our research significantly contributes by providing a tangible, eco-friendly, and sustainable answer to issues stemming from exposure to digital technology. This method directly corresponds with the United Nations Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 13 (Climate Action). Aligned with UNESCO's goal for sustainable education, enhancing children's environmental awareness through nature-based and transdisciplinary pedagogies fosters their growth as active participants in future sustainable communities. This study offers a novel and contemporary contribution to the area, having been executed as a pilot application within the geographical setting of Turkey and substantiated by empirical data acquired through quasi-experimental approaches. The transdisciplinary nature-based play model serves as an effective pedagogical intervention against the detrimental effects of 21st-century digital technology, considerably fostering children's healthy development and improving environmental awareness. Furthermore, our data demonstrate that nature-based activities significantly influence participants' emotional states, suggesting that such interventions may also enhance children's emotional well-being. This study, conducted via the Project-Based Learning (PBL) method, facilitates the conversion of abstract environmental concepts into tangible experiences within the Life Science and Play and Leisure Activities courses. The nature-themed games, characterised by their cost-effective and curriculum-compatible design, enhance environmental awareness. This serves as a significant reference for educators, families, policymakers, and researchers. In conclusion, nature-based games have proven to be an excellent remedy for mitigating the adverse impacts of digital technology, enhancing children's connection to the environment, and promoting the adoption of healthy lifestyles. Furthermore, it has been noted that these educational activities foster the development of children as responsible and ecologically aware individuals by enhancing their connections with nature. The significance of games in safeguarding cultural values and facilitating intergenerational transmission is underscored, along with the imperative to advocate for the incorporation of nature-based activities within educational frameworks. The multidisciplinary nature-based play model remains a vital educational instrument that fosters children's cognitive, emotional, and social development, while also promoting sustainability and equipping them with skills to navigate the problems of the digital era. Subsequent research should examine the applicability and generalisability of this paradigm across many geographic and cultural situations.

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