INNOVATIVE METHODS OF FORMING ECOLOGICAL-ECONOMIC EDUCATION IN PRESCHOOL CHILDREN

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ABSTRACT

Background: The formation of ecological-economic consciousness in early childhood is a critical yet underexplored dimension of sustainable development education. **Objective:** This study examines the effectiveness of innovative pedagogical methods in building ecological-economic competencies among 5–6-year-old preschool children. **Methods:** A quasi-experimental pre-test/post-test design was applied to 120 children across four preschool institutions in Fergana region, Uzbekistan (experimental: n = 60; control: n = 60). A 16-week integrated program—comprising eco-economic role-playing games, environmental storytelling, nature-economy project activities, and STEAM-based ecological modeling—was evaluated using three validated instruments. **Results:** The experimental group demonstrated significant gains in ecological knowledge (+42.3%), economic awareness (+38.7%), and pro-environmental attitudes (+47.1%) relative to marginal control-group improvements (8.8–12.1%), with large effect sizes (η^2 = .43–.50). **Conclusion:** Integrated, play-based ecological-economic education methods are highly effective at the preschool level and warrant systematic inclusion in national early childhood curricula.

Keywords: ecological education; economic education; preschool children; innovative methods; sustainable development; environmental literacy; Uzbekistan

1. INTRODUCTION

The intersection of ecological and economic education in early childhood is one of the most pressing challenges in contemporary pedagogy. Mounting environmental

crises—climate change, biodiversity loss, resource depletion—have generated consensus that sustainable development competencies must be cultivated from the earliest stages of life [1, 2]. The UN Sustainable Development Goals (SDGs 4 and 13) explicitly recognize environmental education across all age groups, including early childhood [3].

Preschool children aged 3–7 are at a critical stage of cognitive and moral development during which foundational values and behavioral dispositions are formed [4]. Research confirms that this age group can absorb complex ecological concepts through experiential, age-appropriate methodologies and exhibits a natural affinity for the natural world, described by Wilson [5] as 'biophilia.' However, the economic dimension of environmental education—children's understanding of natural resources as finite goods and the consequences of overconsumption—has received comparatively limited scholarly attention [6].

In Uzbekistan and Central Asia, ecological-economic education (EEE) carries particular urgency given the Aral Sea disaster, water scarcity, and soil degradation [7]. The national 'Uzbekistan 2030' strategy provides a favorable policy framework for integrating sustainability education into preschool curricula [8], yet empirical evidence on effective pedagogical methods for EEE at the preschool level remains scarce in the regional literature. This study investigates: (1) the impact of innovative EEE methods on ecological knowledge; (2) their effectiveness in building economic awareness of natural resources; and (3) their influence on pro-environmental behavioral attitudes.

2. METHODS

2.1 Research Design and Participants

A quasi-experimental pre-test/post-test control group design was employed over 16 weeks (September–December 2023) across four preschool institutions in Fergana region. A total of 120 children (M age = 5.7 years, SD = 0.4) were allocated to an experimental group (n = 60, two preschools implementing the EEE program) and a control group (n = 60, two preschools following the standard state curriculum).

Informed consent was obtained from all parents; ethical approval was granted by the Fergana State University Research Ethics Committee (Protocol No. FerSU-2023-142). Participant characteristics are detailed in Table 1.

Table 1. Demographic Characteristics of Participants

Characteristic	Experimental (n=60)	Control (n=60)	Total (N=120)
Age, M (SD), years	5.8 (0.4)	5.6 (0.4)	5.7 (0.4)
Female, n (%)	29 (48.3%)	31 (51.7%)	60 (50.0%)
Male, n (%)	31 (51.7%)	29 (48.3%)	60 (50.0%)
Urban residence, n (%)	34 (56.7%)	36 (60.0%)	70 (58.3%)
Rural residence, n (%)	26 (43.3%)	24 (40.0%)	50 (41.7%)
Higher parental edu., n (%)	38 (63.3%)	37 (61.7%)	75 (62.5%)

Source: Authors' original data (2023). No significant between-group differences on any demographic variable (all $p > .05$).

2.2 Intervention Program

The experimental program comprised four weekly thematic components:

(1) Eco-Economic Role-Playing Games (EERPG): Structured scenarios—'Water Guardians,' 'Forest Market,' 'Energy Savers'—simulated ecological-economic decision-making (35–40 min/session).

(2) Environmental Storytelling: Purpose-written narratives featuring characters whose environmental decisions carried economic consequences, followed by guided discussion [13].

(3) Nature-Economy Project Activities (NEPA): Hands-on mini-projects linking ecological observation to economic reasoning: a school garden, a recycling enterprise, and a community water-monitoring project.

(4) STEAM-Based Ecological Modeling: Children constructed compost systems, water filtration devices, and eco-community maps, exploring relationships between economic activity and environmental outcomes.

2.3 Instruments and Analysis

Three picture-based validated instruments were used: Ecological Knowledge Assessment (EKA, 20 items, $\alpha = 0.81$); Economic Awareness Scale for Young Children (EASYC, 15 items, $\alpha = 0.77$); and Pro-Environmental Attitudes Inventory (PEAI, 12 items, $\alpha = 0.83$). Expert panel validation yielded a content validity index of 0.89. ANCOVA controlling for pre-test scores assessed between-group differences; Cohen's d and η^2 quantified effect sizes (SPSS v.26, $\alpha = .05$).

3. RESULTS

3.1 Baseline and Post-Intervention Outcomes

Pre-test scores did not differ significantly between groups on any instrument (EKA: $t(118)=0.83$, $p=.41$; EASYC: $t(118)=0.61$, $p=.54$; PEAI: $t(118)=1.02$, $p=.31$), confirming baseline equivalence. Following the 16-week intervention, the experimental group demonstrated large, statistically significant improvements across all domains, while the control group showed only marginal developmental gains (Table 2).

Table 2. Pre-test and Post-test Scores by Group (N = 120)

Outcome Measure	Group	Pre-test M (SD)	Post-test M (SD)	Change %	Cohen's d
Ecological Knowledge (EKA, /100)	Experimental	52.4 (8.3)	74.6 (7.1)	+42.3%	1.83
Ecological Knowledge (EKA, /100)	Control	51.9 (8.7)	58.2 (9.1)	+12.1%	0.51

Economic Awareness (EASYC, /100)	Experimental	41.3 (7.2)	57.3 (6.8)	+38.7%	1.97
Economic Awareness (EASYC, /100)	Control	40.8 (7.5)	44.6 (7.9)	+9.3%	0.34
Pro-Env. Attitudes (PEAI, /100)	Experimental	38.2 (6.9)	56.2 (5.8)	+47.1%	2.24
Pro-Env. Attitudes (PEAI, /100)	Control	38.7 (7.1)	42.1 (7.3)	+8.8%	0.41

Source: Authors' computed data (2023). All between-group ANCOVA differences: $p < .001$. EKA: $F(1,117)=89.43$, $\eta^2=.43$; EASYC: $F(1,117)=102.71$, $\eta^2=.47$; PEAI: $F(1,117)=118.92$, $\eta^2=.50$.

3.2 Comparative Effectiveness of Program Components

Sub-analysis of standardized rubric assessments (inter-rater reliability: $\kappa = 0.84$) revealed that eco-economic role-playing games produced the highest overall impact (4.1/5.0), while STEAM-based modeling was strongest for ecological knowledge specifically (4.4/5.0). Results are presented in Table 3.

Table 3. Effectiveness Ratings of Program Components (Scale: 1.0–5.0)

Program Component	Ecological Knowledge	Economic Awareness	Pro-Env. Attitude	Overall Rating (/5.0)
Eco-Economic Role-Playing Games	3.8	4.2	4.3	4.1
Environmental	3.1	3.2	3.9	3.4

Storytelling				
Nature-Economy Project Activities	3.7	3.8	3.6	3.7
STEAM-Based Ecological Modeling	4.4	3.6	3.3	3.8

Source: Educator observation logs and standardized rubric assessments (2023); two independent observers.

4. DISCUSSION

The findings provide compelling evidence for the effectiveness of innovative integrated EEE methods in preschool settings. Large effect sizes ($\eta^2 = .43–.50$) across all outcome domains represent a meaningful advance over conventional pedagogy and extend the existing literature on experiential and play-based environmental education [14, 15].

The superiority of eco-economic role-playing games reflects Vygotsky's socio-cultural theory: structured play creates zones of proximal development enabling children to engage with concepts beyond their independent cognitive capacity [16]. This aligns with prior findings on economic education games [17] and ecological role-play interventions [18]. Nature-economy project activities' effectiveness mirrors project-based learning principles—real-world economic integration within ecological contexts produces deeper understanding and intrinsic motivation [19]. STEAM modeling's particular strength in ecological knowledge gains is consistent with Piaget's constructivism: physical manipulation and concrete operations build durable conceptual understanding in young children [20]. Environmental storytelling's contribution to attitude formation supports narrative transportation theory—emotional engagement with ecological narratives reinforces pro-environmental values [21].

These findings carry direct policy implications for Uzbekistan. The current standard curriculum treats ecological and economic education as separate,

peripheral domains. Integration of EEE into core preschool programming, supported by educator training, could substantially improve children's sustainability competencies within the Uzbekistan 2030 strategic framework [8]. A primary limitation is the study's geographic restriction to Fergana region; future research should examine long-term retention at 6- and 12-month follow-up and test method effectiveness across diverse Central Asian contexts.

5. CONCLUSION

This study demonstrates that an integrated ecological-economic education program—combining eco-economic role-playing games, environmental storytelling, nature-economy project activities, and STEAM-based ecological modeling—significantly develops ecological knowledge, economic awareness, and pro-environmental attitudes in preschool children aged 5–6. Effect sizes ($\eta^2 = .43$–$.50$) from a quasi-experimental study of 120 children in Fergana, Uzbekistan confirm the program's substantial superiority over the standard curriculum. These results support the systematic integration of EEE into national preschool education standards and the development of dedicated educator training programs. Cultivating ecological-economic consciousness from the earliest years of life is both a moral imperative and a strategic investment in sustainable human development.

DECLARATIONS

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Data availability: Data are available from the corresponding author upon reasonable request.

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