Empowering Educators for Sustainable Futures: A Study on Readiness and Innovative Pedagogical Strategies for Environmental Education

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***Abstract*— This mixed-method study explores how pre-service and in-service teachers perceive their readiness and competence in delivering environmental education (EE), alongside the pedagogical strategies they employ to foster sustainability. Utilizing a structured questionnaire based on five dimensions—Vision, Readiness, Pedagogical Practices, Classroom Ecology, and Teaching Identity—quantitative and qualitative data were collected from a sample of 116 educators. Methodological triangulation was employed to synthesize numerical trends with narrative reflections. The findings indicate strong alignment in EE vision across groups, with pre-service teachers exhibiting higher confidence in pedagogical innovation and sustainability identity. Qualitative analysis revealed themes of interdisciplinary integration, institutional challenges, and evolving perceptions of sustainability. The study underscores the need for systemic support and targeted training to mainstream environmental education across curricula while affirming the research objectives through multifaceted evidence.**

***Index Terms*—environmental education, in-service teachers, interdisciplinary education, pedagogical innovation, pre-service teachers, sustainability, teacher readiness**

I. INTRODUCTION

The urgency of sustainable development has amplified the call for educators to embed environmental awareness within all subject areas. Both pre-service and in-service instructors are essential in creating students' ecological consciousness as change agents. "Empowering Educators for Sustainable Futures" investigates educators' professional competencies, preparation, and innovative ways to EE integration.

II. LITERATURE REVIEW

This study is conceptually grounded in Transformative Learning Theory, which emphasizes critical reflection and the reshaping of perspectives—an approach well-aligned with the objectives of environmental education. Additionally, the TPACK (Technological Pedagogical Content Knowledge) framework underpins the pedagogical innovation dimension, as it recognizes the intersection of technology, pedagogy, and subject matter in effective teaching practices.

Research emphasizes the transformative potential of environmental education when delivered through interdisciplinary and learner-centered approaches (Stevenson et al., 2013). However, constraints such as curriculum overload, insufficient training, and institutional inertia frequently impede effective integration (Tilbury, 1995). The National Education Policy (NEP, 2020) and National Curriculum Framework (NCF, 2023) advocate for inclusive and holistic EE, urging teachers across disciplines to actively participate.

III. OBJECTIVES

•To assess teachers' vision and beliefs about environmental education.
•To evaluate their readiness and professional competence in EE.
•To identify pedagogical practices used for environmental learning.
•To explore institutional and classroom dynamics influencing EE.
•To understand how teaching identity aligns with sustainability values.

IV. METHODOLOGY

Reliability and Validity - To ensure the quality of the instrument, content validity was established by sharing the questionnaire with professionals in environmental education and teacher training. Their expert feedback guided refinement of items for clarity and relevance. Reliability was assessed using Cronbach's alpha, which yielded a coefficient of

0.97, indicating excellent internal consistency across the five dimensions.

A mixed-method design was employed. Quantitative data were gathered using a Likert scale-based questionnaire distributed via Google Forms. The form comprised 5 dimensions:

1.Vision for Environmental Education
2.Readiness and Professional Competence
3.Innovative Pedagogical Practices
4.Classroom and Institutional Ecology
5.Sustainability-Oriented Teaching Identity

Qualitative insights were collected through five open-ended questions addressing roles, examples, challenges, support needs, and perception shifts. Responses were analyzed thematically using open coding, followed by axial grouping into categories.

Sample: The study involved 116 educators: 60 pre-service and 56 in-service teachers, representing diverse educational contexts.

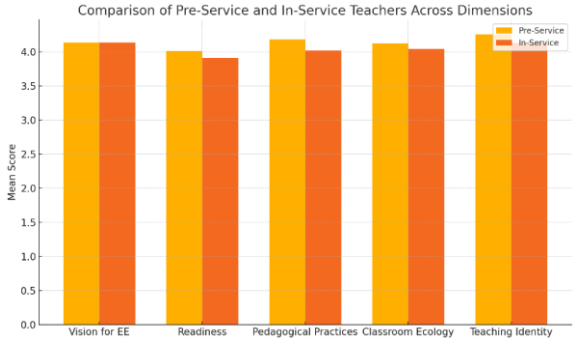
V. RESULTS

Triangulation of Data This study employed methodological triangulation by integrating quantitative scores with qualitative thematic patterns to ensure a holistic understanding of educators' readiness for environmental education. Quantitative metrics provided structured insights into competency levels and pedagogical trends, while qualitative narratives illuminated the contextual factors, reflective practices, and lived experiences behind the numbers. Notably, high mean scores on readiness and identity dimensions corresponded with emergent qualitative themes around commitment, interdisciplinary strategies, and evolving eco-pedagogical identities. This convergence confirms the strength of the findings and validates the mixed-methods strategy.

Quantitative Data Summary

Dimension	Mean (Overall)	Pre-Service Mean	In-Service Mean
Vision for Environmental Education	4.14	4.14	4.14
Readiness & Professional Competence	3.95	4.01	3.91
Innovative Pedagogical Practices	4.10	4.18	4.02
Classroom & Institutional Ecology	4.07	4.12	4.04
Sustainability-Oriented Teaching Identity	4.19	4.26	4.13

Comparison graph of Pre-service and In-service Teachers on their readiness and Pedagogical practices



Qualitative Themes with Codes and Descriptions

Theme	Code	Description	Example Response
Roles of Non-EE Teachers	INT, BEH, ACT	Integration across subjects (INT), modeling eco-conscious behavior (BEH), conducting activities or events (ACT)	"Teachers can include eco-friendly habits and model sustainability in everyday actions."
Challenges	TIME, RES, INST, EXP	Time constraints (TIME), lack of resources (RES), limited institutional support (INST), lack of expertise (EXP)	"Packed curriculum and lack of school-level support make it difficult to focus on EE."
Support Needed	WSHP, TOOLS, LDR	Workshops (WSHP), access to teaching resources (TOOLS), leadership	"Training workshops and support from school heads would

Theme	Code	Description	Example Response
		encouragement (LDR)	help immensely."
Perception Shift	AWR, ID, CORE	Growing awareness (AWR), alignment with teaching identity (ID), sustainability seen as a core value (CORE)	"Initially, I saw sustainability as niche. Now it's central to my teaching."
Project Examples	CREAT, PBL, LOC	Creative classroom integration (CREAT), project-based learning (PBL), local issues focus (LOC)	"I used storytelling and poetry writing around the theme of saving the planet."

VI. ANALYSIS SUMMARY

The quantitative findings reveal that teachers, regardless of experience, generally value environmental education, with pre-service teachers showing a slightly higher inclination toward innovation and identity alignment. The qualitative data deepens this understanding, exposing practical constraints and creative strategies employed by educators. Together, these datasets provide a comprehensive picture of the current readiness and aspirations of educators to champion environmental learning. The synergy between the two data forms enhances credibility and highlights the need for capacity-building initiatives.

Pre-service vs. In-service Comparison

•Pre-service teachers consistently rated higher across all dimensions.

•They exhibited more confidence in adopting innovative methods and aligning teaching identity with sustainability.

•In-service teachers reflected a realistic but slightly constrained approach due to systemic limitations.

•This contrast suggests the benefit of recent training and curriculum exposure among pre-service teachers.

VII. DISCUSSION

The triangulated data reveal a promising outlook: educators acknowledge the urgency of EE and demonstrate willingness to adapt. Quantitative scores affirm strong support for environmental education across both groups, while qualitative responses emphasize practical strategies and perceived barriers. The alignment between expressed vision and lived challenges highlights a need for stronger institutional scaffolding. Pre-service teachers, still immersed in updated training, show greater agility in adopting innovative EE methods. Institutional ecosystems play a crucial role, with supportive environments boosting integration efforts (UNESCO, 2017).

VIII. CONCLUSION AND RECOMMENDATIONS

This study confirms the research objectives by triangulating quantitative and qualitative insights. Educators' visions, readiness, pedagogical practices, institutional contexts, and teaching identities converge toward sustainability advocacy. To scale EE integration, teacher education must:

•Embed EE across training curricula.

•Provide interdisciplinary, project-based learning resources.

•Foster professional learning communities.

•Promote leadership-driven green initiatives.

Limitations

Geographic concentration and self-reported data may limit generalizability. Future studies could explore longitudinal impacts and broader demographics.

IX. IMPLICATIONS FOR POLICY AND PRACTICE

The findings suggest that environmental education should be systematically embedded into teacher education curricula, not just as a thematic focus but as a foundational pedagogical lens. Teacher training institutions can leverage these insights to enhance curriculum modules with interdisciplinary EE content. Furthermore, connecting institutional priorities with SDG 4.7—ensuring that learners gain the information and skills required to support sustainable development—has the potential to bridge the gap between policy and classroom reality.

The research objectives outlined were thoroughly addressed through both quantitative assessments and qualitative reflection. Educators' visions for environmental education were clearly articulated and supported by high mean scores, while readiness and competence were substantiated by both item-level

responses and qualitative descriptors of applied practices. Innovative pedagogical approaches, institutional conditions, and sustainability identities were all explored and validated across the dataset, indicating alignment between the study's goals and its findings.

Environmental education has to develop a common professional ethic that cuts across academic divisions.

Recommendations include:

•Integrating EE modules in all teacher education programs

•Offering interdisciplinary, project-based learning toolkits

•Providing regular training and communities of practice

•Encouraging school-wide green initiatives and leadership involvement

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