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Inculcating Environmental Science Values in Primary Students Using Artificial Intelligence Methods: Integrating Subject Content with Modern Educational Needs

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Abstract

Environmental education at the primary level plays an important role in developing responsible, sensitive, and scientifically minded citizens. Children naturally possess curiosity about their surroundings, but this curiosity needs to be nurtured through meaningful experiences, appropriate teaching methods, and child-centred approaches. The teaching of Environmental Science (EVS) provides opportunities for children to understand nature, living organisms, natural resources, environmental problems, and their responsibilities towards the environment. The present action research study examines the effectiveness of Artificial Intelligence (AI)-supported, child-centred strategies in inculcating environmental values and scientific attitude among primary students. The study was conducted with primary students through a structured intervention involving AI-assisted storytelling, interactive questioning, visual learning resources, environmental problem-solving tasks, digital observation activities, project-based learning, and reflective discussions. The intervention connected EVS content with students' everyday experiences, including water conservation, waste segregation, biodiversity, cleanliness, energy use, and protection of local surroundings. A mixed-method action research design was used. Data were collected through pre- and post-intervention environmental value scales, scientific attitude checklists, classroom observations, student worksheets, project records, interviews, and reflective journals. The findings indicated improvement in students' environmental awareness, participation, questioning skills, observation, cooperation, problem-solving, and willingness to adopt environmentally responsible practices. The study also revealed that AI tools were most effective when used as supportive resources under teacher guidance rather than as substitutes for direct experience, discussion, experimentation, and outdoor learning. The study emphasizes that Environmental Science should not be treated merely as a textbook subject. It should become an experiential, ethical, and meaningful learning process connected with children's everyday lives. AI-supported pedagogy can enrich this process by providing differentiated explanations, visualisation, immediate feedback, language support, and opportunities for creative expression. However, responsible use requires attention to digital access, age-appropriate content, privacy, accuracy, teacher supervision, and the balance between technology-based learning and real-world environmental experiences.

Keywords — Environmental Science, Artificial Intelligence, Action Research, Scientific Attitude, Primary Education, Environmental Values, Experiential Learning, Inquiry-Based Learning, Sustainability

I. INTRODUCTION

Environmental problems such as pollution, water scarcity, deforestation, loss of biodiversity, excessive waste, climate change, and unsustainable consumption affect all communities. Developing environmental awareness and responsible behaviour must therefore begin during the early years of schooling. Primary education provides an important foundation for forming habits, attitudes, values, and ways of thinking that influence children's future relationship with nature and society.

Environmental Science at the primary level is not limited to the study of plants, animals, air, water, soil, food, shelter, transport, and human relationships. It also helps children understand interdependence, responsibility, conservation, health, cleanliness, social cooperation, and sustainable living. When EVS is taught through direct observation, questioning, experimentation, storytelling, local examples, and

practical activities, children are more likely to connect classroom learning with their own lives.

Artificial Intelligence has introduced new possibilities for teaching and learning. AI-supported tools can generate age-appropriate explanations, create stories and questions, provide visual representations, support multilingual learning, offer differentiated tasks, and help teachers analyse learning evidence. In EVS, AI can be used to simulate environmental situations, compare ecosystems, classify waste, develop conservation plans, and encourage students to think about possible solutions to local problems.

At the same time, technology alone cannot develop environmental values. Values are formed through experience, reflection, emotional connection, social interaction, responsible action, and repeated practice. Therefore, AI should be integrated with hands-on activities, outdoor observation, group work, project-based learning, and teacher-led discussion. The present action research was undertaken to examine how such integration could support the development of environmental values and scientific attitude among primary students.

II. NEED AND SIGNIFICANCE OF THE STUDY

Many primary students can recall definitions related to the environment but may not consistently demonstrate environmentally responsible behaviour. They may know that water should be saved but leave taps running, understand the importance of cleanliness but mix waste, or identify plants and animals without recognising their interdependence. This gap between knowledge and action indicates the need for teaching approaches that combine understanding, emotional engagement, practical participation, and reflection.

Traditional teacher-centred methods often emphasise textbook reading, explanation, memorisation, and written exercises. These methods may provide information but may not sufficiently develop observation, questioning, investigation, decision-making, cooperation, or responsible action. Primary students require opportunities to learn through their senses, experiences, conversations, play, creativity, and participation in real-life activities.

AI-supported learning may help address some of these needs by providing multiple explanations, creating stories and problem situations, supporting visual and auditory learning, offering language translation and simplified content, generating differentiated activities, providing immediate feedback, helping teachers organise classroom evidence, encouraging creative expression, connecting local environmental issues with wider concerns, and supporting inquiry and problem-solving when combined with real-world observation.

However, the educational value of AI depends on how it is used. Unsupervised or excessive use may encourage passive learning, reduce direct interaction with nature, reproduce inaccurate information, or create dependence on technology. The present study therefore focused on a balanced model in which AI served as a teacher-guided support for experiential and action-oriented EVS learning.

III. STATEMENT OF THE PROBLEM

"An action research study to examine the effectiveness of AI-supported, child-centred Environmental Science activities in developing environmental values and scientific attitude among primary students."

IV. OBJECTIVES OF THE STUDY

1. To identify the existing level of environmental awareness and environmental values among primary students.

2. To examine students' existing scientific attitude in relation to observation, questioning, evidence, and problem-solving.

3. To design and implement AI-supported EVS activities connected with local environmental issues.

4. To develop students' understanding of conservation, cleanliness, biodiversity, waste management, water use, and sustainable living.

5. To encourage students to observe, question, investigate, communicate, and take responsible environmental action.

6. To compare students' environmental values before and after the intervention.

7. To compare students' scientific attitude before and after the intervention.

8. To study students' participation, cooperation, creativity, and problem-solving during the intervention.

9. To examine the usefulness and limitations of AI tools in primary EVS teaching.

10. To develop practical recommendations for teachers using AI responsibly in environmental education.

V. RESEARCH QUESTIONS

1. What is the existing level of environmental awareness and environmental values among the selected primary students?

2. What scientific attitudes do students demonstrate before the intervention?

3. How can AI-supported activities be integrated with hands-on and child-centred EVS learning?

4. What changes occur in students' environmental values after the intervention?

5. What changes occur in students' scientific attitude after the intervention?

6. How do students respond to AI-supported stories, visuals, questions, simulations, and feedback?

7. What challenges arise while using AI in primary EVS classrooms?

8. How can teachers ensure that AI use remains ethical, inclusive, age-appropriate, and connected with real environmental action?

VI. HYPOTHESES

1. There will be a positive improvement in students' environmental values after participation in AI-supported EVS activities.

2. There will be a positive improvement in students' scientific attitude after participation in the intervention.

3. Students will demonstrate greater participation and interest in EVS when AI is integrated with activity-based and inquiry-based learning.

4. Students will show improved ability to connect EVS concepts with local environmental problems.

5. Students will demonstrate increased willingness to adopt environmentally responsible practices after the intervention.

VII. OPERATIONAL DEFINITIONS

Environmental Values: Environmental values refer to students' attitudes, feelings, beliefs, and behavioural intentions related to cleanliness, conservation, respect for living organisms, responsible use of resources, waste reduction, biodiversity protection, and sustainable living.

Scientific Attitude: Scientific attitude refers to curiosity, objectivity, open-mindedness, willingness to ask questions, respect for evidence, careful observation, logical thinking, cooperation, and readiness to revise ideas when new evidence is available.

Artificial Intelligence-Supported Learning: AI-supported learning refers to the teacher-guided use of AI-enabled tools and resources for generating age-appropriate explanations, stories, questions, visuals, simulations, feedback, language support, and learning activities.

Primary Students: Primary students in this study refer to learners studying in the selected primary class or classes of the researcher's school.

Action Research: Action research is a systematic, reflective, and classroom-based process in which a teacher identifies a problem, plans an intervention, implements it, collects evidence, reflects on the results, and modifies practice for improvement.

VIII. REVIEW OF RELATED LITERATURE

Environmental education aims to develop knowledge, awareness, attitudes, skills, participation, and responsible behaviour. Effective environmental education is not limited to information transmission. It requires learners to understand relationships between human beings and the natural world and to participate in solving environmental problems.

Experiential learning theories emphasise that children learn effectively through direct experience, reflection, conceptual understanding, and application. EVS activities such as observing plants, measuring water use, sorting waste, maintaining a school garden, and documenting local biodiversity provide meaningful experiences through which children can construct knowledge.

Inquiry-based learning encourages students to ask questions, collect information, examine evidence, and communicate conclusions. It is particularly suitable for EVS because environmental issues are connected with observation and investigation.

Constructivist approaches view learners as active participants who build understanding by connecting new experiences with prior knowledge. AI can support constructivist learning by presenting alternative explanations, generating questions, and helping students represent their ideas. However, the teacher must ensure that students do not simply accept AI-generated responses without examination.

Collaborative learning supports communication, cooperation, empathy, and shared responsibility. Environmental problems require collective action, and group activities can help students understand that individual and community behaviour are interconnected.

Technology-enhanced learning can increase engagement and provide access to varied resources. AI tools may support personalisation, language accessibility, visualisation, and formative assessment. Nevertheless, concerns include inaccurate information, algorithmic bias, privacy risks, unequal access, excessive screen time, and reduced opportunities for direct interaction with nature. Responsible integration therefore requires teacher supervision, verification of

content, protection of student data, and a clear educational purpose.

The present study builds on these perspectives by combining AI-supported resources with direct observation, practical activities, group discussion, environmental projects, and reflection.

IX. METHODOLOGY

The study adopted a classroom-based action research design. The research followed a cyclical process: identification of the classroom problem; collection of baseline information; planning of an intervention; implementation of AI-supported EVS activities; observation and documentation; assessment of learning and behavioural changes; reflection on the intervention; and planning of further improvement.

A mixed-method approach was used to combine quantitative evidence with qualitative classroom observations and student reflections.

Participants: The participants were primary students from the researcher's school in Pune, Maharashtra. The selected class consisted of approximately 30–40 students in the primary stage. The students represented varied learning levels, language backgrounds, interests, and degrees of access to digital devices.

Sampling: Purposive sampling was used because the researcher selected the class in which the environmental learning problem had been identified. The class was considered suitable for action research because the researcher had regular access to the students and could observe the intervention over time.

Duration: The intervention was implemented over approximately eight weeks: one week for baseline assessment and planning; six weeks for implementation of activities; and one week for post-intervention assessment, reflection, and analysis.

Variables: The main independent variable was the AI-supported, child-centred EVS intervention. The dependent variables were environmental awareness, environmental values, scientific attitude, participation in EVS activities, environmental action and responsible behaviour, and ability to communicate environmental understanding.

Tools for Data Collection: Environmental Values Scale; Scientific Attitude Checklist; Classroom Observation Schedule; Student Worksheets; Environmental Project Rubric; Student Reflection Sheets; Group Discussion Records; Teacher Reflective Journal; Informal Student Interviews; and pre-test and post-test achievement tasks.

X. AI-SUPPORTED INTERVENTION

Activity 1: AI-Supported Environmental Storytelling — The teacher used an AI tool to prepare age-appropriate stories about a water drop, a tree, a sparrow, a plastic bag, or a village pond. The stories were reviewed and modified by the teacher before classroom use. After listening to a story, students discussed the environmental problem, affected parties, causes, alternative actions, and possible actions in school or home. Students then created alternative endings, drawings, dialogues, or short role-plays.

Activity 2: AI-Generated Question Prompts — AI was used to generate questions at different levels: recall, understanding, application, analysis, evaluation, and creation. The teacher selected and adapted questions according to students' age, language level, and local context.

Activity 3: Water Conservation Investigation — Students observed water use in the school and recorded situations in which water was used. They discussed possible wastage and prepared suggestions for conservation. AI-supported resources were used to explain the water cycle, generate a simple water-use diary, and create visual comparisons of careful and wasteful water use. Students then carried out a real school-based water audit under teacher supervision.

Activity 4: Waste Segregation and Recycling — Students collected examples of common classroom waste and classified them into appropriate categories. AI-supported prompts and visual examples helped students discuss biodegradable, recyclable, reusable, and non-recyclable materials. Groups designed a "Waste-Free Classroom" plan and created posters encouraging correct segregation.

Activity 5: Local Biodiversity Observation — Students conducted an outdoor observation walk around the school premises. They recorded plants, birds, insects, and other living organisms they noticed. AI-supported identification prompts were used only as supplementary resources, while observations were checked through teacher guidance and available reference materials. Students prepared simple biodiversity charts and discussed why local organisms are important.

Activity 6: Energy Conservation Challenge — Students investigated the use of lights, fans, and other electrical devices in classrooms. They identified situations of unnecessary energy use and proposed practical solutions. AI-generated scenarios helped students compare different choices and discuss the environmental consequences of energy consumption.

Activity 7: Environmental Problem-Solving — Groups were presented with local problem situations such as littering, plastic waste, water leakage, lack of plants, or unnecessary electricity use. AI was used to generate possible alternatives, but students were

required to evaluate the ideas and select solutions that were realistic for their school. Each group prepared an action plan.

Activity 8: Creative Environmental Expression — Students used their learning to create poems, slogans, posters, short speeches, role-plays, stories, and presentations. AI was used selectively to provide prompts or language support. Students were encouraged to develop their own ideas rather than copy AI-generated material.

Activity 9: Reflection and Responsible Action — At the end of each activity, students reflected on what they had learned, what surprised them, what environmental behaviour they wanted to change, and what action they could take. Students maintained simple reflection sheets or journals. The teacher recorded observations of changes in participation and behaviour.

XI. DATA ANALYSIS AND INTERPRETATION

Because this is classroom action research, the collected evidence can be analysed using both quantitative and qualitative methods.

Quantitative analysis may include: mean pre-test and post-test scores; percentage improvement; item-wise comparison of environmental values; item-wise comparison of scientific attitude; frequency of responsible environmental behaviours; and rubric scores for projects.

Percentage Improvement = ((Post-test Score − Pre-test Score) / Pre-test Score) × 100

Qualitative analysis may include coding student responses under themes such as curiosity, observation, cooperation, environmental responsibility, problem-solving, creativity, and application of learning.

XII. EXPECTED / OBSERVED FINDINGS

The classroom evidence from the intervention was expected to show improvement in several areas. Students became more willing to ask questions about environmental issues and more confident in sharing their observations. Activities involving real water use, waste, plants, animals, and energy helped students connect textbook concepts with daily life.

Students showed increased participation in group tasks and demonstrated greater willingness to cooperate while investigating environmental problems. Project activities encouraged creativity and communication. Reflection activities helped students identify environmentally responsible behaviours that could be practised at home and school.

AI-supported storytelling and visual resources were particularly useful for gaining attention and introducing environmental situations. AI-generated questions helped the teacher provide different levels of challenge. However, students benefited most when AI resources were followed by direct observation, discussion, experimentation, and action.

The intervention also highlighted the importance of teacher mediation. Students needed support to distinguish reliable information from incorrect or oversimplified AI-generated responses. This reinforced the principle that AI should function as a learning support rather than an authority.

XIII. DISCUSSION

The action research suggests that integrating AI with child-centred EVS pedagogy can create a richer learning environment. AI can increase the variety of explanations and learning materials available to the teacher while helping students engage with environmental problems through stories, questions, visualisation, and creative tasks.

However, environmental values cannot be developed through digital exposure alone. A child may understand water conservation through an AI-generated explanation but develop a stronger value when the child actually observes a leaking tap, measures water wastage, discusses its consequences, and participates in correcting the problem.

Similarly, biodiversity learning becomes more meaningful when students observe living organisms in their own surroundings. AI can help generate background information or questions, but direct experience provides the emotional and sensory connection needed for value formation.

The intervention therefore supports a blended pedagogical model: AI-assisted preparation and representation combined with teacher facilitation, inquiry, outdoor learning, practical action, collaboration, and reflection.

XIV. LIMITATIONS OF THE STUDY

1. The study was limited to a selected primary class or classes and therefore may not represent all primary students.

2. The duration of approximately eight weeks was relatively short for measuring long-term behavioural change.

3. Access to digital devices and internet connectivity may have varied among students.

4. Some environmental values were measured through self-report, which may be influenced by socially desirable responses.

5. AI-generated information required teacher verification because AI systems may produce inaccurate or incomplete responses.

6. The study was conducted within the researcher's own classroom context, which may introduce observer bias.

7. The study did not attempt to measure long-term environmental behaviour after the intervention ended.

XV. CONCLUSION

Environmental Science education at the primary level should move beyond memorisation and become an experiential process through which children observe, question, understand, value, and act. The integration of Artificial Intelligence with child-centred and activity-based EVS teaching provides useful opportunities for differentiated explanations, storytelling, questioning, visualisation, language support, creative expression, and formative feedback. When carefully planned, these tools can make environmental concepts more accessible and engaging.

The central finding of the action research is that technology is most educationally valuable when it strengthens—not replaces—human interaction and direct experience. Environmental values develop when children participate in meaningful activities, see the consequences of their choices, cooperate with others, reflect on their actions, and repeatedly practise responsible behaviour.

Therefore, AI should be viewed as a supportive pedagogical resource within a broader framework of experiential learning, inquiry, collaboration, outdoor observation, project-based learning, and environmental action.

XVI. RECOMMENDATIONS

1. Teachers should use AI only with a clear learning objective.

2. AI-generated information should be reviewed and verified before classroom use.

3. AI activities should be followed by real-world observation or practical action wherever possible.

4. Teachers should avoid excessive screen time and maintain a balance between digital and non-digital learning.

5. Students should be encouraged to question and evaluate AI responses rather than accept them automatically.

6. Environmental activities should be connected with local issues and students' everyday experiences.

7. Schools should promote projects such as water audits, waste segregation, tree care, biodiversity observation, and energy conservation.

8. Teachers should provide age-appropriate and inclusive learning materials.

9. Student privacy and personal data should be protected when digital tools are used.

10. Schools should provide professional development for teachers on responsible and educationally meaningful AI use.

11. Parents can be involved in home-based environmental action activities.

12. Future studies should examine the long-term effect of AI-supported environmental education on actual behaviour.

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Note: The supplied paper states that numerical pre-test/post-test findings should be based on the researcher's actual classroom data; therefore, no numerical values have been fabricated in this formatted version.

