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Teacher-Led Initiatives Associated with EE in Kindergartens: A Case Study in Hong Kong

Vicky Wing Kei Wong | | vickywong@ctihe.edu.hk
HKCT Institution of Higher Education, Department of Education, New Territories, Hong Kong

Abstract

Environmental education (EE) has become important in early childhood because it equips children with the knowledge that they need to understand how ecosystems function and how to promote sustainability. Despite the significance of EE in early childhood education, it has been challenging for teachers to implement EE activities. This has mainly been caused by insufficient knowledge, practical experience, and confidence. This mixed-method case study examined the impact of a teacher-led initiative designed to support the integration of EE into kindergarten classrooms in Hong Kong. The study relied on data collected from six kindergarten teachers who participated in a professional development programme. Quantitative data were collected using questionnaires, while qualitative data were obtained through observations, field notes, and teacher reflections. According to the quantitative data analysed in this study, participation in the initiative was associated with increases in knowledge and attitudes toward EE, confidence in implementing EE, and improved integration of EE strategies in classroom activities. The Wilcoxon Signed-Rank Test analysis showed that improvement in classroom practice was statistically significant, while increases in knowledge and confidence were a reflection of positive but non-significant trends. Qualitative findings indicated increased teacher awareness of environmental concepts, greater willingness to incorporate EE into daily teaching, and enhanced capacity to design play-based environmental learning experiences. Both quantitative and qualitative findings suggest that professional development, collaborative planning, and reflective practice are critical in supporting the integration of EE in early childhood education. This study used a small sample size and a single design. Therefore, the findings should be interpreted as exploratory and context-specific.

Keywords: Environmental education, Kindergarten curriculum, Teacher-led training, Sustainability

Citation

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Introduction

Environmental Education (EE) is increasingly recognised as a vital component of early childhood education (ECE), particularly within the Asia-Pacific region. Recent research highlights a rapid expansion in EE scholarship and growing recognition of its developmental benefits for children (Ardoin & Bowers, 2020). Exposure to EE during the early years has the potential for a profound lifelong impact. Scholars have identified early childhood (birth to age eight) as a critical period for the development of environmental literacy, with learning processes during this stage being shaped primarily by sensory and hands-on experiences (Ardoin & Bowers, 2020; Fortino et al., 2014). While much of the extant literature focuses on policy and curricular frameworks, less is known about the practical processes and impacts of teacher-led EE initiatives in densely populated urban environments. Hong Kong offers a salient case, where the confluence of high-density city living, diverse cultural influences, and evolving governmental priorities presents both challenges and opportunities for effective EE integration in early childhood settings. To address these gaps, the present study examines changes associated with teacher-led EE initiatives in Hong Kong kindergartens using a convergent mixed-methods case study design.

Significance of EE

EE in early childhood lays the foundation for children's environmental values, skills, and knowledge. EE empowers young learners to engage with environmental issues and develop practical responsibility, fostering attitudes and behaviours essential for long-term sustainability (Chawla, 2015).

Preprimary EE in Hong Kong

The Curriculum Development Council's (CDC) (2017) Kindergarten Education Curriculum Guide positions EE as a key part of early learning, particularly through the "Nature of Living" domain, which encourages appreciation and care for the environment via sustainable practices. Other curriculum areas, such as "Self and Society" and "Physical Fitness", reinforce positive environmental values and healthy habits. Activities such as field trips and recycling projects help cultivate environmental citizenship in young children (CDC, 2017).

Educators play an essential role in cultivating environmentally friendly habits in young children. The Environmental Protection Department (EPD, 2021) emphasises that effective EE equips individuals to make informed decisions and contribute to conservation. Nevertheless, challenges persist—such as limited funding, insufficient teacher preparation, and gaps in environmental literacy among practitioners—which hinder more widespread EE integration (Husin et al., 2025). Although Husin et al. (2025) was published after the completion of the 2023 intervention, it is referenced here to contextualise ongoing regional challenges in EE implementation. Addressing these barriers is therefore crucial for supporting effective EE in Hong Kong's kindergartens.

Research Objectives

This study examines changes associated with teacher-led EE initiatives in Hong Kong's kindergartens. The objectives are:

1. To assess how teacher training is associated with teachers' capacity to integrate sustainability into daily teaching practices (Evans, 2020).
2. To examine how EE is incorporated across the kindergarten curriculum (K1-K3), considering curriculum design, classroom activities, and learning themes.
3. To examine how teacher-led EE activities are related to children's environmental knowledge, attitudes, and behaviours, and related classroom artefacts.
4. To investigate changes in teachers' EE knowledge, understanding, and classroom practice, as reflected in lesson planning, assessments, classroom observation, and pre-and post-intervention surveys.

Research Questions

This study addresses the following research questions:

1. How are teacher training programmes associated with EE implementation in Hong Kong kindergartens?
2. How are teaching practices associated with the integration of EE into the kindergarten curriculum?
3. What changes in children's environmental awareness and behaviours did teachers observe during the EE activities?
4. How are teachers' understanding and implementation of EE reflected in their classroom practices and integration strategies?

Significance of the Research

This study is significant for educators, researchers, and policymakers concerned with early childhood EE. The findings provide preliminary evidence of self-reported changes following teacher-led EE programmes associated with curriculum integration and professional practice in Hong Kong's urban kindergartens. This research also highlights the specific challenges and opportunities related to implementing EE in densely populated city settings, offering insights relevant to broader Asia-Pacific contexts.

Overview of the ECE System in Hong Kong

ECE in Hong Kong serves children aged 3–6 and aims to foster cognitive, social, emotional, and physical development (Lee & Ma, 2006). The kindergarten system consists of three progressive levels: K1 (ages 3–4), K2 (4–5), and K3 (5–6). According to the Kindergarten Education Curriculum Guide (CDC, 2017), Hong Kong's ECE emphasises holistic growth, integrating values, attitudes, and knowledge through play-based and experiential learning (EPD, 2021). Key EE activities—such as nature exploration, recycling, gardening, and outdoor learning—help young children develop environmental awareness and positive attitudes (Wong & Cheng, 2019; Wilson, 2018). These activities are supported by methods including storytelling, role-playing, and inquiry-based learning, which enrich children's environmental literacy (Shutaleva, 2023). Hong Kong's blend of high-density living and Eastern and Western education traditions presents both unique challenges and opportunities for EE integration – a pattern echoed in other Asia-Pacific urban centres.

Effectiveness of Teacher Training Programmes

Franzen (2017) underscores teacher training as a critical driver of environmental literacy and effective EE implementation. Robust professional development programmes have been shown to positively influence teachers' attitudes and equip them to integrate sustainability concepts into classroom environments by enhancing teachers' knowledge, confidence, and classroom practices relating to EE (Chawla, 2015; Chen et al., 2015; Kuo, Barnes, & Jordan, 2019). Importantly, training also addresses persistent misconceptions about environmental issues. Wilson (2018) reports that enhanced self-efficacy gained from these programmes enables teachers to deliver environmental lessons more confidently, improving children's outcomes. With appropriate knowledge and tools, teachers can organise more meaningful outdoor activities, helping children build emotional connections to nature (Wong & Cheng, 2019). Empirical findings show that hands-on activities, such as gardening or nature exploration, foster children's empathy toward nature (Rakotomamonjy et al., 2014). Experiential and narrative approaches deepen children's environmental engagement and pro-environmental attitudes (Shutaleva, 2023; Chawla, 2020). Professional development in EE must also meet teachers' changing needs. As Liu and Feng (2020) note, effective professional learning equips teachers with the competencies required to embed sustainability into their teaching practices in both content and behaviour. Teachers trained in EE can act as role models, fostering sustainable values not only in lessons but through their actions as well (Franzen, 2017). The Hong Kong context demonstrates the need for integrating EE into routines and projects, using play and inquiry to engage children (Ardoin & Bowers, 2020). Nevertheless, the diversity of classroom contexts and teacher preparedness suggests that a one-size-fits-all approach may be insufficient, highlighting the need for more context-sensitive research. Collectively, these studies suggest that while professional development generally enhances teachers' EE capacity, its actual effectiveness is shaped by programme quality, local adaptation, institutional support, cultural values, and urban constraints. Localised adaptations and ongoing professional development are necessary for sustained change—especially in unique, resource-intensive urban environments such as Hong Kong.

Taken together, the evidence indicates that teacher training enhances environmental knowledge and professional confidence. However, its effectiveness is strengthened when knowledge development is combined with practical application in authentic classroom contexts. Practical engagement allows teachers to translate conceptual understanding into pedagogical action, reinforcing the critical link between knowledge and implementation. Across studies, improvements in self-efficacy consistently emerge as a mediating factor in successful EE integration. Nevertheless, evidence also indicates variation in how such gains are sustained across different cultural, institutional, and urban contexts. This indicates that teacher training alone may be insufficient to sustain meaningful EE integration without ongoing contextual adaptation, collaborative reflection, and institutional support mechanisms.

Integration of EE into the Kindergarten Curriculum

Embedding EE across the kindergarten curriculum affords children a more holistic understanding of sustainability (Palmer, 1998). Integrative approaches allow environmental themes to permeate subjects like science, social studies, and the arts. Monroe et al. (2007) emphasise the importance of Tilbury's (1995) framework—education about, in, and for the environment—which supports knowledge, direct engagement, and action. In practice, education about the environment develops knowledge, education in the environment uses direct experience, and education for the environment encourages active participation and problem-solving (Wong, 2025).
Case studies in Chinese kindergartens demonstrate that integrating EE with theme-based approaches enriches learning (Lee & Ma, 2006). Teachers who embed environmental goals within thematic projects and daily routines facilitate deeper connections for young learners.

Based on the literature reviewed, integrating EE across multiple curricular areas promotes a more holistic understanding of sustainability by situating environmental issues within children's everyday experiences. However, the literature also reveals a recurring challenge: while curriculum frameworks advocate integrative approaches, successful implementation depends heavily on teachers' interpretive capacity and the contextual conditions in which teaching occurs. Evidence suggests that integration is most effective when teachers can meaningfully connect environmental themes with children's interests, developmental needs, and lived experiences. In densely populated urban contexts, where access to natural environments may be limited and learning spaces constrained, these implementation challenges may be amplified. Consequently, there remains a need for empirical research that examines how environmental curriculum integration is operationalised within urban early childhood settings.

Outcomes of EE Activities

Studies suggest that EE activities enhance children's understanding of environmental systems and promote sustainable behaviours (Rakotomamonjy et al., 2014; Wilson, 2018; Haberg et al., 2023; Elliot et al., 2014). Practical learning—such as horticulture, recycling, or conservation—encourages pro-environmental attitudes (Iwasaki, 2022). Real-world scenarios and dramatisations help children realise the environmental impact of daily choices (Wong, 2025). Storytelling and outdoor experiences are effective in fostering emotional responsiveness and a sense of responsibility (Chawla, 2020). While existing research demonstrates positive short-term outcomes, evidence regarding the long-term sustainability of these effects remains limited, particularly across differing rural and urban contexts.

Hands-On Experiences

Experiential methods are widely recognised as central to meaningful EE (Shutaleva, 2023). Studies across various contexts demonstrate that drama, eco-films, pictorial books, and hands-on activities deepen environmental knowledge and engagement (Ye & Shih, 2020; Georgopoulos et al., 2011). Activities such as recycling, gardening, and nature play strengthen children's empathy and reinforce the connection between knowledge and behaviour (Sukma et al., 2020). However, limitations in physical space and access to natural environments—particularly in densely populated urban settings—may constrain opportunities for sustained experiential learning, highlighting the need for further contextual research.

Impact of Teachers' Awareness, Understanding, and Implementation Plans

Collaborative, reflective, teacher-driven interventions have demonstrated improvement in teachers' environmental awareness, understanding, and pedagogy (Kalsoom et al., 2022). Hands-on training that includes equipment handling and post-lesson reflection contributes to sustained behaviour change and greater ownership among teachers (Kuswandono, 2012). Matsui (2021) notes that regular self-analysis empowers teachers to refine their techniques and develop a repertoire of effective EE strategies. The literature consistently identifies teacher awareness as foundational to effective EE. However, awareness and understanding alone do not guarantee classroom implementation; sustained practice change requires confidence, pedagogical competence, and structured instructional strategies.

Research Gap

Despite considerable progress, most research in EE is centred on primary and secondary education (Franzen, 2017), with limited evidence on how teacher training programmes shape environmental literacy and teaching practice

among early childhood educators, particularly in relation to sustained classroom implementation and the unique demands of Hong Kong's urban settings (Wong & Cheng, 2019). Furthermore, much of the existing literature focuses on policy frameworks or curricular intentions rather than examining how professional development translates into everyday classroom practice. This area of focus is not only significant for Hong Kong but also has implications for ongoing EE policy and teacher education efforts throughout the densely urbanised Asia-Pacific region. By investigating teacher-led, contextually responsive EE initiatives in a Hong Kong kindergarten, this study contributes new, locally relevant insights into how professional development, teacher confidence, and classroom practice interact to support effective EE integration in urban early childhood settings.

Analytical Framework for Teacher Development

To address this gap, this study is guided by an analytical framework informed by recent scholarship on teacher professional learning in EE, which consistently identifies three interrelated domains as vital for effective and sustained change: teachers' knowledge and attitudes, professional confidence (or self-efficacy), and the implementation of new practices in the classroom (Guskey, 2002; Chawla, 2015; Chen et al., 2015; Bandura, 1997; Wilson, 2018). Knowledge provides the conceptual foundation for teaching environmental topics, while confidence is closely linked to teachers' self-efficacy and willingness to adopt new pedagogies.
Drawing on these insights, this study adopts an analytical framework comprising three core domains: (1) environmental knowledge and attitudes, (2) professional confidence in teaching EE, and (3) classroom EE practices (see Figure 1). This framework informs the structure of the research instruments—including pre- and post-intervention surveys, classroom observations, and qualitative coding—and guides the analysis and interpretation of the intervention outcomes.

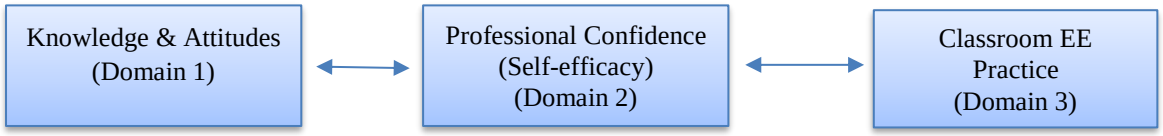

Figure 1. Analytical framework for teacher professional development in EE

Method

Research Design

This study adopted a convergent mixed-methods case study design, grounded in action research principles (Kemmis & McTaggart, 2005; Yin, 2018). Both quantitative and qualitative data served complementary purposes. Quantitative data helped to measure changes in teachers' knowledge, confidence, and classroom implementation before and after the intervention. On the other hand, qualitative data helped to explain why the changes occurred. Qualitative and quantitative datasets were analysed differently, and their findings were compared and interpreted together. This was important because it helped to identify areas of convergence and divergence. To strengthen the credibility of the findings, a triangulation was conducted, where multiple data sources were integrated.

Participants and Sample Selection

A purposive sampling approach was used to select a private kindergarten in an urban district of Hong Kong. All six teachers at the school participated in the two-semester intervention (February–December 2023). These teachers had between two and twenty-five years of teaching experience and diverse qualifications, ranging from Certificates of Education to bachelor's degrees and postgraduate diplomas. Three of the teachers served as peer mentors during the action research cycles. Approximately 60 children were present in the three observed classes. Child-level data were derived from teacher observations and classroom field notes, as the study focused on teachers' EE implementation. As a single-site case study, the findings are context-specific.

Intervention Procedure

Following cyclical phases of action research, the intervention began with a needs assessment. All teachers then attended a three-hour workshop led by the researcher, introducing practical teaching methods covering four areas: environmental issues, hands-on strategies, daily routine integration, and building teacher confidence for child-led discussions. In subsequent cycles, three "seeding teachers" (one per K1–K3) partnered with the researcher for lesson planning, classroom observation, and reflective group discussions. Throughout the intervention, the seeding

teachers also participated in peer-support activities. The specific activities included sharing lesson plans, discussing the implementation challenges that teachers might face, exchanging feedback, and identifying strategies that can be used to improve the integration of EE. These mentoring activities were important because they created a platform or avenue for teachers to learn from each other. The project concluded with a school exhibition, teacher reflections, post-intervention questionnaires, and a final group debrief.

Data Collection and Instruments

Data were collected using both quantitative and qualitative methods to ensure a comprehensive analysis of changes in teachers' knowledge, confidence, and EE implementation processes.
Quantitative data were obtained through pre- and post-intervention questionnaires administered to all six teachers. Responses were rated on a 5-point Likert scale. The pre-intervention questionnaire established baseline awareness and self-efficacy, while the post-intervention survey assessed changes following the workshop and classroom implementation.

Qualitative data provided further insight into the practical integration of EE at various levels of school life. Collaborative lesson plans were developed by the three seeding teachers in partnership with the researcher. Across the intervention period, the researcher conducted nine structured classroom observations (three with each seeding teacher), using both checklists and open field notes to document implementation fidelity and evidence of effective EE strategies. Each observation was recorded using a standardised assessment form covering four domains: teaching plan, environment setup, activity implementation, and teacher self-reflection. Observation ratings were based on predefined criteria. Classroom observations were assessed using a standardised observation rubric that covered four different dimensions, namely: teaching plan, environment setup and resource utilisation, implementation of activities, and teacher self-reflection. A Five-point rating scale was used to evaluate each of the dimensions, where 1 indicated very limited evidence while 5 indicated strong and consistent evidence. The researcher played two different roles in this study: primary observer and professional development facilitator. The researcher conducted this study with the awareness of researcher bias. To reduce the potential of researcher bias, the researcher triangulated observation findings with field notes, reflective discussions, questionnaire results, written teacher reflections, and project artefacts.

Open field notes were also taken to capture classroom dialogue and teacher-child interactions. Additionally, three reflective group discussions were held with only the seeding teachers, focusing on their experiences and challenges. Artefacts generated throughout the project offered further qualitative evidence of project outcomes and teacher collaboration. At the conclusion of the project, written self-reflections were submitted by all six teachers, providing insight into their learning and reflections on the professional development process. Observation data were analysed using thematic analysis alongside teacher reflections and focus group transcripts, focusing on EE integration and child engagement.

The primary quantitative instrument, the teacher questionnaire, was developed specifically for this study. To ensure content validity, a panel of two early childhood education specialists reviewed all questionnaire items for clarity, relevance and alignment with the study objectives. The instrument was refined based on their feedback. The 25 items were organised into three subscales: (1) knowledge and attitudes toward EE (Q1, Q2, Q6, Q10, Q13, Q17, Q20); (2) confidence in implementing EE practices (Q4, Q7, Q8, Q11, Q14, Q15, Q18, Q21, Q24); and (3) integration of EE strategies in classroom activities (Q3, Q12, Q16, Q19, Q22, Q23, Q25). Higher scores represented stronger agreement or confidence. All subscales demonstrated satisfactory internal consistency, with Cronbach's alpha values exceeding 0.80. The full questionnaire is provided in Appendix A.

To supplement self-reported data, structured classroom observations provided an objective account of how EE strategies were applied in practice. These observations, along with the data from the semi-structured reflective group discussions (conducted with the seeding teachers only) and written self-reflections submitted by all teachers, enriched the qualitative dataset and enabled a nuanced analysis of the professional development outcomes.

Data Analysis

Quantitative and qualitative data were analysed both separately and jointly, providing a comprehensive assessment of self-reported changes associated with the intervention. Quantitative analysis was performed using the Statistical Package for the Social Sciences (SPSS). Pre- and post-intervention teacher responses were summarised using descriptive statistics to illustrate trends. Qualitative analysis was conducted on data from joint lesson plans,

classroom observations, transcripts of reflective sessions, exhibition records, and teacher self-reflective comments. All qualitative data were transcribed, reread, and inductively coded. Member checking further ensured the trustworthiness of the themes. Qualitative findings provided insight into the cultural and institutional factors underlying these increases in post-test scores. Due to the small sample size (n = 6) and the paired pre–post design, a non-parametric analysis was adopted using the Wilcoxon Signed-Rank Test to compare pre- and post-intervention questionnaire scores. Both qualitative and quantitative findings were interpreted together to identify similarities and differences between the findings.

Trustworthiness and Ethics

Credibility was supported through triangulation of data sources (questionnaires, observations, reflections, and artefacts) and member checking, allowing participants to validate the interpretations. Confirmability was addressed through researcher reflexivity and collaborative interpretation with teachers to minimise bias. Informed consent was obtained from all participants, and the study received approval from the institutional review board. The researcher acted as both the facilitator and data collector. This could raise credibility concerns due to the potential of researcher bias. To address potential bias, researcher reflexivity was used. The researcher compared interpretations against multiple sources of evidence. Similarly, participants were allowed to verify the accuracy of emerging themes.

Results and Discussion

Qualitative Research Relating to the EE Programme

The qualitative analysis of the EE project draws on comprehensive field notes, teacher reflections, and records from collaborative lesson planning sessions. Three key and interconnected themes emerged: (1) transformation in teaching practice, (2) development of child-centred environmental agency, and (3) the cultivation of a collaborative professional culture among teachers.

Change in Teaching Practice

The project was associated with a shift from traditional, directive teaching toward experiential and inquiry-based approaches. For example, K1 teachers used story content and hands-on activities to help young children connect environmental protection to daily life. In K2, children learned to make environmentally friendly enzymes from fruit peels, with enthusiastic parental participation.

As the intervention progressed, teachers increasingly adopted hands-on and child-centred pedagogies. The K3 teacher used stories like “Summer is Here” and real-life weather chart observations to guide children in exploring how human activity relates to environmental issues such as the greenhouse effect and global warming. The teacher in K2 also leveraged culturally relevant events, using recycled paper to make eco-friendly lanterns instead of disposable glow sticks, and engaging children in practical comparisons of different types of lanterns and their environmental impact. As one teacher reflected: "I used to rely heavily on storybooks, but planning with my colleagues gave me the courage to try letting children experiment with real materials. I saw them develop ownership of the project in a way I hadn’t before."

Despite these advances, some lessons still reflected gaps, particularly in fostering critical thinking and addressing broader environmental issues. This highlights a need for more structured facilitation of ecological discussions to deepen conceptual integration (Melis et al., 2020). These findings align with Ernst and Tornabene (2012), who emphasise that inquiry-driven EE enhances conceptual understanding and engagement (Tilbury, 1995).

Across the nine classroom observations, assessment form ratings consistently showed satisfactory to excellent scores (4 or 5 out of 5) in child engagement and activity implementation. Field notes documented specific shifts, such as K1 children actively picking up rubbish from a sand pit, K2 children successfully making enzymes from fruit peels, and K3 children generating environmental protection charter items. These observations triangulate teacher-reported changes and illustrate EE integration in practice.

Child-Centred Environmental Agency Development

Classroom observation documented that children were observed participating actively in environmental decision-making. In K1, children reflected on the impact of garbage on beaches and marine life. In K2, children discussed

reducing food waste, bringing fruit peels from home for enzyme-making. In K3, after weather and environmental discussions, children articulated connections between energy use and climate change and developed strategies for daily conservation. Teachers noted children's ability to propose solutions: "Children suggested opening windows instead of using air conditioning, taking public transport, and reducing single-use plastics."

Collaborative Culture of Professional Teachers

Growing collaboration and reflection among teachers emerged. The mentoring model promoted lesson sharing and peer support. Seeding teachers reported that sharing lesson plans and regular meetings allowed all colleagues to adopt EE strategies: "Through lesson plans, I can pass on this knowledge to teachers who were not involved in the training. Other teachers can then incorporate the elements of EE into their teaching content and design relevant materials." Teachers described "supporting each other through sharing mentor suggestions and comments during regular teaching reviews, allowing everyone to learn together."

This aligns with professional learning community models, highlighting collaboration as central to professional growth (Stoll et al., 2006). Teachers also noted challenges in skillfully integrating EE themes across diverse topics and ensuring systematic curriculum organisation,

Quantitative Research Relating to the EE Programme

The quantitative findings from pre- and post-intervention questionnaires reinforce and extend the qualitative results. Analysis centred on three domains: (1) teachers' knowledge and attitudes towards EE, (2) confidence in implementing EE practices, and (3) the integration of EE strategies into classroom activities.

Reliability of Measurement Instruments

The internal consistency of each questionnaire subscale was evaluated using Cronbach's alpha. All scales demonstrated strong reliability (Table 1).

Table 1. Cronbach's Alpha Reliability Coefficients for Questionnaire Subscales

Construct	Pre-Test Alpha	Post-Test Alpha
Knowledge	0.89	0.93
Confidence	0.90	0.92
Practice	0.76	0.87

Summary of Quantitative Findings

According to the Wilcoxon Signed-Rank Test, after the intervention, teachers' knowledge and attitudes toward EE increased. At pre-test, the mean score was 3.02, and at post-test, the mean score increased to 3.21. This increase suggested a positive impact on teacher-led initiatives. However, the increase did not attain the statistical significance level ($p = 0.102$). These results suggest a positive trend in teachers' environmental knowledge and awareness. In regard to teachers' confidence, the participants reported higher levels of confidence when implementing EE practices and participating in the programme. The mean scores during the pre-test were 2.57. After the intervention, the mean scores increased to 3.02. Despite this improvement, the scores did not achieve a favourable statistical significance ($p = 0.080$). The findings indicate a positive shift in teachers' self-reported confidence and willingness to implement EE activities. The most significant improvement was evident in classroom practice. This was evident in the significant change of mean scores, from 2.95 to 3.26. This increment was statistically significant ($p = 0.031$), indicating measurable improvements following the intervention. This suggests that teachers' ability to implement EE strategies in classroom settings improved meaningfully.

Table 2. Pre- and Post-Intervention Comparisons of Teacher EE Outcomes Using the Wilcoxon Signed-Rank Test

Domain	Pre-Test Mean	Post-Test Mean	Mean Difference	Wilcoxon p-value
Knowledge & Attitudes	3.02	3.21	+0.19	0.102
Confidence	2.57	3.02	+0.45	0.080
Classroom Practice	2.95	3.26	+0.31	0.031*

Integrating Quantitative and Qualitative findings

Quantitative trends in knowledge and confidence aligned with qualitative evidence of increased hands-on implementation and collaborative planning. Teachers with higher post-intervention confidence were more likely to facilitate child-led inquiry and environmental discussions, demonstrating convergence across data sources.

Specifically, the qualitative theme of transformation in teaching practice was reflected in the quantitative gains in classroom practice scores. Teachers expressed uncertainty about the integration of environmental concepts at the outset, but as the intervention progressed, their confidence grew alongside their observed use of inquiry-based approaches. The qualitative finding of child-centred environmental agency was supported by quantitative increases in teacher confidence, as more confident teachers were more likely to facilitate child-led decisions and decision-making. Finally, the theme of collaborative professional culture was evident. It was reflected in teachers' shared planning, peer support, and reflective discussions. Collaboration positively influenced multiple aspects of teacher development.

These findings align with previous research (e.g., Chen et al., 2015; Kalsoom et al., 2022), which emphasises the value of experiential professional learning and collaborative reflection in supporting teachers' use of interactive, sustainability-focused teaching strategies.

Conclusion

The current study evaluated the self-reported changes following a teacher-led EE training programme in a Hong Kong kindergarten, examining shifts in teacher awareness, understanding, classroom practice, and related children's outcomes. Results revealed that after the intervention, teachers' confidence, knowledge, and classroom practice improved. However, only classroom practice achieved statistical significance. This indicates that the intervention was more effective in strengthening classroom integration of environmental concepts than in significantly increasing teachers' knowledge and confidence. Instructional practices were strengthened, and teachers observed children engaging more actively with environmental topics, though challenges persisted in teaching complex concepts such as energy conservation and the greenhouse effect. Both qualitative and quantitative evidence indicate that frequent, interactive, experiential EE activities were associated with more positive environmental attitudes and behaviours among participating children. As one of the few mixed-methods EE interventions reported in Hong Kong kindergartens, this study offers locally grounded insights that may be relevant to other high-density urban contexts in Asia. The findings suggest that with the help of teacher-driven EE, it is possible to foster climate literacy among children in childhood education.

Limitations

Several limitations should be acknowledged. The sample was small and drawn from a single kindergarten, limiting generalizability and restricting transferability to similar contexts. As a context-bound urban case study, findings are shaped by local institutional and curricular conditions; application elsewhere requires consideration of contextual differences. Although the action research extended across two terms, its focus was primarily on medium-term outcomes, and long-term sustainability remains unknown. The scope of the EE training was relatively narrow, mainly emphasising local recycling, with less attention given to broader environmental topics and resources essential for comprehensive community engagement. There was also significant reliance on self-reported teacher data and indirect assessment of children's outcomes, raising the risk of response bias. The researcher's dual role as both facilitator and data collector may have introduced additional bias, though reflexivity and triangulation measures were taken to help mitigate this concern.

Further Research

To address these limitations, future research should adopt a broader and more methodologically rigorous approach. Studies that include a larger and more diverse sample of kindergartens—across multiple districts and varying community contexts—would greatly enhance the generalisability of results. Implementing longitudinal designs is recommended to assess the long-term effectiveness and sustainability of EE training, particularly in terms of lasting changes to teachers' practices and children's environmental behaviours. Future investigations should also expand the scope of training content to encompass a wider array of environmental themes and promote deeper community engagement. Researchers are encouraged to employ validated, robust assessment instruments and independent observational protocols to systematically evaluate both teacher and children's outcomes. Incorporating direct, objective measures of children's environmental knowledge, attitudes, and behaviours—such as pre- and post-intervention child interviews, standardised tasks, or independent classroom observations—will

enable more reliable attribution of effects to teacher-led interventions. Future studies should minimise research bias by involving independent evaluators in data collection and analysis. Further studies examining how shifts in teachers' competencies translate into changes in children's attitudes, behaviours, and ecological awareness would clarify the mechanisms underlying EE interventions.

Recommendations

The findings of this study suggest several ways to enhance environmental EE training programmes in kindergartens. Training programmes should be comprehensive, sustainable, and extended over the long term, incorporating both foundational knowledge and reflective practice. Specifically, targeted professional development should address knowledge gaps on more complex topics, such as the greenhouse effect and local recycling systems, to equip teachers with the conceptual depth required for effective EE integration. Sustained training should include continuous opportunities for skill refinement through peer mentoring, collaborative lesson planning, and regular workshops. Reflective practices, such as self-evaluation, peer discussions, and the use of professional journals, should be embedded to foster ongoing professional growth.

Furthermore, teachers are encouraged to adopt interactive and experiential instructional methods, which can increase engagement and environmental awareness among young learners. Schools should prioritise access to outdoor learning spaces and eco-friendly materials to support these interactive methods. Strengthening parent and community involvement—through activities such as recycling drives, tree planting, and family-oriented environmental projects—can reinforce environmental values both in school and at home. Finally, longitudinal research is recommended to evaluate the sustained impact of EE training on teachers and children alike, deepening understanding of its long-term efficacy. Importantly, these findings suggest that even small-scale, teacher-focused professional development may contribute to improvements in EE practices at the school level. Therefore, educational leaders and policymakers should consider supporting the expansion of collaborative professional development models and allocating resources to extend these efforts to a broader range of kindergartens.

Ethical Approval

Ethical approval for this study was obtained from the Research Coordination and Development Committee, HKCT Institute of Higher Education Approval Date: 29.12.2024; Approval Number: Not applicable).

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