

Teacher-Led Initiatives in Promoting Environmental Education in Kindergartens: A Case Study in Hong Kong

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ABSTRACT - Environmental Education (EE) has become an increasingly important component of early childhood education as educators are expected to nurture children's environmental awareness, sustainable behaviours, and ecological responsibility from an early age. Despite the growing emphasis on Education for Sustainable Development (ESD), empirical evidence examining how teacher-led professional development facilitates the successful integration of EE into kindergarten curricula remains limited, particularly within highly urbanised educational contexts such as Hong Kong. Addressing this research gap, this study investigated the effectiveness of a collaborative teacher-led EE initiative in enhancing teachers' environmental knowledge, instructional confidence, curriculum integration, and children's environmental learning outcomes. A mixed-methods case study incorporating action research principles was conducted over seven months in a Hong Kong kindergarten. Six teachers participated in a structured professional development programme consisting of environmental education workshops, collaborative lesson planning, classroom implementation, lesson evaluation, reflective discussions, and ongoing mentoring. Quantitative data were collected using pre- and post-intervention questionnaires measuring teachers' environmental knowledge, awareness, confidence, and instructional practices. Qualitative data were obtained through classroom observations, lesson plans, reflective field notes, teacher discussions, and children's learning artefacts. Descriptive statistics, paired-samples *t*-tests, correlation analyses, and thematic analysis were employed to analyse the data. The findings demonstrated significant improvements in teachers' environmental knowledge, instructional confidence, and readiness to integrate EE across multiple curriculum themes. Collaborative lesson planning and continuous professional support enhanced teachers' pedagogical competence, resulting in more interactive, inquiry-based, and experiential learning activities. Classroom observations further indicated positive changes in children's environmental awareness, curiosity, participation, and environmentally responsible behaviours. Nevertheless, persistent challenges were identified, including limited instructional resources, insufficient time allocation, and teachers' uncertainty when introducing complex environmental concepts. This study contributes to the emerging literature on teacher professional development in Environmental Education by demonstrating that sustained collaborative support, rather than one-off training, plays a critical role in strengthening teachers' pedagogical capacity for implementing EE in early childhood settings. The findings provide

practical recommendations for policymakers, curriculum developers, and teacher educators seeking to strengthen Education for Sustainable Development through systematic professional learning and collaborative curriculum innovation in kindergarten education.

INTRODUCTION

Environmental Education (EE) is continuously recognised as a vital early childhood education (ECE) component. This particular realm of research in ECE on EE is experiencing dynamic growth in research and practice due to the persistent environmental challenges coupled with burgeoning interest in the documented benefits of nature-rich experiences for infants and children (Ardoin & Bowers, 2020). EE has a lifelong impact. Ardoin and Bowers (2020) elucidate that early childhood presents a developmental time essential for environmental literacy, often from birth to age eight. Environmental degradation, climate change, biodiversity loss, pollution, and unsustainable consumption have emerged as some of the most pressing global challenges of the twenty-first century. These environmental issues threaten not only ecological sustainability but also human health, economic stability, and social well-being. Consequently, education has increasingly been recognised as a critical mechanism for fostering environmental awareness, promoting sustainable lifestyles, and developing environmentally responsible citizens. Within this context, Environmental Education (EE) has become an essential component of Education for Sustainable Development (ESD), enabling learners to acquire the knowledge, values, attitudes, and competencies required to address current and future environmental challenges.

Children develop an understanding of the world through play and exploration, essential learning mediums for learning about the environment. Fortino et al. (2014) elucidate it as a period where a child primarily acquires knowledge through practical encounters and senses. Educators have a vital role in enabling children to know and understand various concepts through such vital learning mediums. Herein, educators inculcate environmental concepts to children, allowing them to be aware of their surroundings and adopt sustainable habits as early as they are enrolled in kindergarten. This research will explore how educator-led efforts influence environmental literacy and education in children living in Hong Kong to contribute to the existing understanding of ECE in EE in an urban context. Research increasingly demonstrates that children's environmental attitudes are established long before formal schooling. Experiences involving outdoor exploration, play-based learning, nature observation, and direct interaction with natural environments positively influence children's cognitive development, environmental awareness, empathy towards living organisms, and sense of responsibility for environmental conservation. These early experiences also contribute to children's scientific inquiry, creativity, problem-solving abilities, and emotional well-being. Consequently, early childhood settings have become important contexts for implementing Environmental Education through developmentally appropriate pedagogical approaches that combine exploration, inquiry, and authentic learning experiences.

Despite growing recognition of the importance of Environmental Education, integrating sustainability concepts into early childhood curricula remains challenging. Unlike primary and secondary education, early childhood programmes require learning experiences to be developmentally appropriate, play-based, and meaningful for young children. Environmental concepts must therefore be translated into concrete, engaging, and age-appropriate activities rather than abstract scientific explanations. Achieving this transformation depends largely on teachers' pedagogical competence, environmental knowledge, instructional confidence, and professional commitment.

Teachers play a pivotal role in determining the quality and effectiveness of Environmental Education implementation. They are responsible not only for delivering curriculum content but also for designing learning environments that encourage curiosity, critical thinking, environmental stewardship, and sustainable behaviours. However, previous studies consistently report that many early childhood educators experience uncertainty when teaching environmental concepts due to limited subject knowledge, inadequate professional preparation, insufficient instructional resources, and lack of confidence in translating sustainability principles into classroom practice. Consequently, teacher professional development has emerged as one of the most significant determinants of successful Environmental Education implementation in early childhood settings.

Professional development extends beyond the acquisition of factual knowledge. Contemporary educational research suggests that effective teacher learning occurs through continuous collaboration, reflective practice, mentoring, classroom experimentation, and professional learning communities rather than isolated workshops. Collaborative lesson planning, peer reflection, and classroom-based inquiry enable teachers to refine their pedagogical practices while adapting Environmental Education to children's developmental needs and local curriculum requirements. Such collaborative approaches encourage sustained professional growth and facilitate meaningful curriculum innovation that is responsive to both educational objectives and contextual realities.

Background

EE is a significant concept in ECE, instilling values, skills, and knowledge while empowering children to understand their active involvement in environmental matters and concerns. Educators utilise EE to improve young learners' practical expertise and their sense of respect and responsibility for the environment. Moreover, Chawla (2015) elucidates that engaging children in EE is a sustainable approach to improving environmental sustainability.

The Curriculum Development Council's (CDC) (2017) Kindergarten Education Curriculum Guide provides various educational scopes the kindergarten's learning framework should emphasise. The 'Nature of Living' is one such learning domain with various objectives, emphasising appreciating, respecting, and caring for nature and living an environmentally friendly life while caring and appreciating the beauty of nature. Other learning expectations outlined in the objectives include developing attitudes and habits of protecting the environment and cherishing resources (CDC, 2017). Two other domains, 'Self and Society' and 'Physical Fitness' also emphasise environmental care and sustainable practices including the need to love the environment and care for the local community and positive values and attitudes and hygiene habits as necessities for good living habits.

Through the integrated EE into the curriculum, learning institutions foster these objectives by planning for field trips to conservation areas and nature reserves and incorporating sustainable initiatives in the learning settings. Learners also enhance their involvement in environmental activities, including recycling, beach cleaning, and tree-planting initiatives, further promoting environmental advocacy. Societies and environmental corporations in HK have also collaborated with educational institutions to support EE by empowering learners with real-life expertise in environmental conservation. According to the CDC (2017), such initiatives create a society of responsible citizens with moral values and respect for the environment, as the kindergarten curriculum paradigm underscores.

Educators nurture such values and skills in children in their early years to acquire environmentally friendly habits. The Environmental Protection Department [EPD] (2021) also outlines EE's aim to empower individuals to make informed choices and engage in environmental conservation efforts. However, despite significant initiatives towards EE integration into the ECE curriculum, limited resources and inadequate professional training, among other conceptual barriers, continue to limit environmental literacy and the delivery of sustainable-oriented lessons (Husin et al., 2025). Hence, further studies are vital to explore instructor-led initiatives in improving EE through the kindergarten curriculum.

Research Objectives

The research evaluates professional educator training programs' impact on EE. In defence of 'Education for Sustainability' (EfS), Evans (2020) elucidates that teacher training is crucial in fostering sustainable education and ensuring that educators obtain adequate knowledge, skills, and attitudes essential in enhancing their understanding of environmental challenges so that they can transfer the knowledge to their students. It explores methods of developing and integrating EE into the existing kindergarten curriculum in HK while considering each level's (K1-K3) syllabus, including activities and learning themes. The research also assesses the effects of the EE activities implemented by the teachers in kindergarten, which involve evaluating what children know or are aware of concerning the environment, behaviours exhibited by children towards their environment, and products and/or artifacts developed by children as they undergo EE. It explores teachers' recognition of the need for innovative change in EE. Lesson assessment and planning, classroom observation, and pre-and post-test survey questionnaires will help evaluate educators' change in attitudes, beliefs, and behaviours regarding environmental education.

Research Questions

The following scientific inquiries will be addressed in this research.

1. How effective are educator training initiatives in enhancing EE in Hong Kong's kindergartens?
2. How can we ensure effective EE integration into the current kindergarten curriculum in HK?
3. How do teachers' EE activities impact children's attitudes, behaviours, and knowledge?
4. What is the impact of teachers' understanding, awareness, and execution plans on EE based on the study intervention?

Significance of the Research

The current study is important to various stakeholders, including teachers, research experts, and policymakers. The study outcomes will demonstrate the effectiveness of educator-led programs in improving EE implementation in kindergartens. Also, the research findings will add to the current knowledge concerning environmental literacy within urban contexts, particularly in HK, by providing insights into challenges and opportunities emerging from EE's integration into the kindergarten curriculum.

METHODOLOGY

The current section introduces and justifies the mixed-methods case study research design and the action research principles employed to investigate the impact of a teacher training program on advancing EE in kindergartens in HK. The research emerged to fill gaps observed in other scholars' works on incorporating environmental ideas into early learning programs (Liu & Feng, 2020; Tan et al., 2021; Wong & Cheng, 2019; Mashaba et al., 2022).

Research Design

This study adopted a mixed-methods single-case study embedded within an action research framework to examine the effectiveness of collaborative teacher-led Environmental Education (EE) initiatives in promoting curriculum integration and enhancing children's environmental learning in a Hong Kong kindergarten. A mixed-methods design was considered appropriate because the study sought not only to measure changes in teachers' environmental knowledge, confidence, and instructional practices quantitatively but also to explore how these changes were translated into authentic classroom practices and children's learning experiences through qualitative inquiry.

This research employed a mixed-methods case study approach to comprehensively enhance the procedures' understanding, as Yin's article (2018) suggested. The case being evaluated and analysed is in a kindergarten setting in different durations. This design effectively collected quantitative and qualitative data from a single research setting to address 'how' and 'why' questions, as Baxter and Jack (2008) suggested. The research was guided by the pragmatic paradigm, recognising that complex educational phenomena cannot be adequately understood through a single methodological approach. Quantitative data provided measurable evidence of teachers' professional growth before and after the intervention, whereas qualitative data generated contextual insights into teachers' pedagogical decision-making, collaborative planning, classroom implementation, and children's responses during Environmental Education activities. Integrating both forms of evidence enabled methodological triangulation and strengthened the credibility of the findings.

A single-case design was deemed appropriate for this study's purpose of documenting the teacher training program's effectiveness on one kindergarten school site for multiple time points (Creswell & Poth, 2016). Survey questionnaires offered numerical information that provided an overall improvement or deterioration idea concerning teachers' awareness, knowledge, and self-confidence as influenced by the program. The study also employed principles of collaborative action research, whereby the researcher worked closely with participating teachers throughout the planning, implementation, observation, reflection, and refinement stages of the intervention. Rather than functioning solely as an external evaluator, the researcher acted as a collaborative facilitator who supported teachers in integrating Environmental Education into the existing kindergarten curriculum while simultaneously documenting changes in professional practice. This iterative process allowed continuous reflection and improvement throughout the seven-month intervention.

Data collection and analysis procedures followed for the qualitative data included reviewing documents containing lesson plans and notes on observational fields and providing 'how' the ideas of EE were implemented into instructions. Incorporating classroom observations enabled the researcher to obtain first-hand information regarding any changes that might have occurred in the teaching practices and the activities being conducted. Qualitative and quantitative data effectively affirmed the case using different triangulation techniques (Yin, 2018). This approach helped answer research questions since the two forms of data provided different narratives and trends on the same findings (Creswell & Creswell, 2018). The chosen case study was suitable for this investigation as the eventual development of EE initiatives had to be tested and assessed on actual practice grounds (Yin, 2018). Therefore, this study's results can help guide the design of subsequent related programs and research studies in other schools.

Research Context

The study was conducted in a private kindergarten located in an urban district of Hong Kong that had initiated a school-based Environmental Education project entitled "A New Generation of Environmental Protection Started by Young Children: Children's Environmental Education School-Based Teacher Training and Curriculum Planning."

The project was implemented across two consecutive academic semesters between 2022 and 2024 and sought to strengthen Environmental Education by integrating sustainability concepts into the existing curriculum rather than introducing additional standalone subjects. This school context provided an appropriate setting for examining how collaborative professional development could facilitate sustainable curriculum innovation within authentic classroom practice.

Participants

Six teachers participated voluntarily in the study. They represented the entire teaching workforce within the kindergarten and included educators responsible for Kindergarten 1 (K1), Kindergarten 2 (K2), and Kindergarten 3 (K3) classes. Among these participants, three teachers were purposively selected as seeding teachers because they assumed leadership roles during collaborative curriculum planning and classroom implementation.

Purposive sampling was employed because the selected participants were directly involved in the Environmental Education intervention and possessed first-hand experience regarding curriculum planning, instructional implementation, and reflective evaluation throughout the project. Their active participation enabled an in-depth examination of teacher professional learning within a real educational context, consistent with the objectives of qualitative case study research.

Although the sample size was relatively small, the purpose of the investigation was not statistical generalisation but rather analytical generalisation through an in-depth understanding of teacher learning processes within a naturally occurring educational setting.

Teacher Professional Development Intervention

The intervention extended over approximately seven months and comprised four interconnected phases.

Phase 1: Needs Assessment

The project commenced with preliminary consultations between the researcher and participating teachers to identify existing challenges, professional learning needs, and opportunities for integrating Environmental Education into the kindergarten curriculum. Teachers completed baseline questionnaires assessing their environmental knowledge, confidence, instructional practices, and awareness.

Phase 2: Professional Learning Workshop

All six teachers attended a structured three-hour Environmental Education workshop facilitated by the researcher. The workshop introduced contemporary Environmental Education concepts, sustainable teaching strategies, curriculum integration techniques, and examples of developmentally appropriate environmental learning activities suitable for early childhood classrooms.

Phase 3: Collaborative Curriculum Planning

Following the workshop, three collaborative lesson-planning sessions were conducted with the seeding teachers representing K1, K2, and K3. During these meetings, Environmental Education concepts were systematically embedded within existing curriculum themes, including *Summer*, *Mid-Autumn Festival*, and *Autumn*. Lesson plans were jointly reviewed, refined, and evaluated before classroom implementation to ensure developmental appropriateness and alignment with curriculum objectives.

Phase 4: Classroom Implementation and Reflective Evaluation

Teachers implemented the collaboratively designed Environmental Education lessons within their classrooms. Throughout implementation, the researcher conducted classroom observations, documented field notes, facilitated reflective discussions, and reviewed children's learning artefacts. Continuous feedback enabled teachers to refine subsequent lessons while strengthening pedagogical confidence and curriculum integration.

Data Collection

To enhance methodological rigour, data were collected from multiple complementary sources.

Quantitative Data

Quantitative evidence was collected using researcher-developed pre- and post-intervention questionnaires adapted from established Environmental Education teacher self-efficacy instruments. The questionnaires measured teachers'

- environmental knowledge,
- environmental awareness,
- instructional confidence,
- curriculum integration practices,
- implementation readiness.

The use of pre- and post-measurements enabled evaluation of professional growth following participation in the intervention.

Qualitative Data

Qualitative evidence consisted of:

- three collaborative lesson-planning documents;
- three lesson evaluations;
- nine classroom observations;
- teacher reflective discussions;
- observation field notes;
- children's learning artefacts;
- photographs documenting Environmental Education activities.

These multiple sources enabled triangulation while providing comprehensive insights into how teachers translated Environmental Education principles into classroom practice.

Instrument Validity and Trustworthiness

Several procedures were employed to strengthen methodological quality.

The questionnaire items were adapted from previously validated Environmental Education instruments and subsequently reviewed by experts specialising in Environmental Education and Early Childhood Education to establish content validity.

Trustworthiness of qualitative findings was enhanced through:

- methodological triangulation;
- prolonged engagement throughout the seven-month intervention;
- member checking with participating teachers;
- reflective field notes;
- audit trail documentation;
- collaborative interpretation of emerging themes.

These procedures enhanced the credibility, dependability, confirmability, and transferability of the findings.

Data Analysis

Quantitative data were analysed using IBM SPSS Statistics.

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarise teachers' responses.

To determine whether significant differences existed between pre- and post-intervention scores, paired-samples *t*-tests were performed. Pearson correlation analyses were subsequently conducted to examine relationships among teachers' environmental knowledge, instructional confidence, and curriculum implementation.

Qualitative data were analysed using Braun and Clarke's (2006) six-phase thematic analysis. Initially, all qualitative materials were read repeatedly to achieve data familiarisation. Codes were then generated inductively before being organised into preliminary themes. Themes were reviewed, refined, defined, and interpreted through continuous comparison across observation records, lesson plans, reflective journals, and teacher discussions. Integration of quantitative and qualitative findings occurred during interpretation, allowing comprehensive understanding of teacher professional learning throughout the intervention.

Ethical Considerations

Ethical principles were carefully observed throughout the research process. Permission to conduct the study was obtained from the participating kindergarten prior to data collection. All participating teachers voluntarily agreed to participate and provided informed consent before the commencement of the project. Participants were informed of the study's objectives, confidentiality procedures, and their right to withdraw from the research at any stage without penalty.

To protect anonymity, teachers' identities and institutional information were anonymised throughout data analysis and reporting. Children's learning artefacts and classroom photographs were used solely for research purposes and handled according to institutional ethical guidelines. All collected data were securely stored and accessed only by the research team.

RESULTS

The results focus on EE's impact on teachers' concepts' awareness, understanding, and implementation concerning the environment. This section utilises the data collected from pre-and-post-training questionnaires, providing qualitative and quantitative analyses to evaluate teacher knowledge and practice changes. By comparing the results before and after the intervention, it highlights significant

trends, patterns, and improvements in the participants' environmental literacy and instructional strategies.

Effectiveness of Teacher Training Programs

Descriptive statistics were conducted to get a general overview of the data distribution about teachers' assessment of their knowledge about the environment, as per Table 1 below.

Table 1. Self-Assessment of Environmental Knowledge

Q2. How knowledgeable do you consider yourself about environmental issues?		
N	Valid	6
	Missing	0
Mean		2.00
Median		2.00
Mode		2

Table 1 demonstrates the results of self-reported data about teachers' knowledge, asserting that most respondents have a relatively low knowledge level. The average for the results above is 2.00, which is equal to the mode and median, implying that the teachers are slightly knowledgeable about environmental issues. This distribution of responses supports a perceived belief that teachers' environmental knowledge is limited. The fact that all three measures of central tendency are equal at this level implies that all the teachers have, in equal capacity, indicated that their knowledge is insufficient. This finding points out a potential lack of specialist EE expertise and the need for further development efforts to improve faculties' abilities and efficiency in teaching environmental subjects.

Bridging this gap could enhance the quality of EE when integrated into learning institutions. Further testing of the frequencies of the responses was done to understand the teachers' assessment of their knowledge concerning the environment, and the results are shown in Table 2 below.

Table 2. Frequencies of the Responses

Q2. How knowledgeable do you consider yourself about environmental issues?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	slightly knowledgeable	1	16.7	16.7	16.7
	moderately knowledgeable	4	66.7	66.7	83.3
	very knowledgeable	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

The results in Table 2 above demonstrate the diversity of teachers' nature of perception from their self-evaluation knowledge concerning environmental issues. The findings showed that most (66.7%) teachers had 'moderate' knowledge about environmental issues. This implies that most teachers believe they can partly know but not nearly fully as depicted. Conversely, 16.7% believe they have 'slight knowledge' or much knowledge about the topics. This distribution suggests a polarized view where a small proportion of teachers feel less or more confident in their knowledge.

Nonetheless, while the results imply that most teachers believe they have a moderate understanding of environmental problems, there is an opportunity for improvement. The fact that neither lies on the 'less knowledgeable' side or 'highly knowledgeable' side, reflecting both ends of the spectrum, demonstrates the need for professional development initiatives to improve teachers' environmental knowledge levels. Advanced training is warranted to equalize the knowledge level, potentially contributing to the EE quality provided to learners.

Confidence Level Analysis in Teaching Environmental Concepts

Table 3. Waste Reduction Content Delivery Before and After Training

Q4. How confident do you feel in teaching students about reducing waste?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident at all	1	16.7	16.7	16.7
	Slightly confident	1	16.7	16.7	33.3
	Moderately confident	3	50.0	50.0	83.3
	Very confident	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately confident	3	50.0	50.0	50.0
	Very confident	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Table 4. Water Conservation Content Delivery Before and After Training

Q8. How confident are you in teaching students about conserving water resources?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident at all	1	16.7	16.7	16.7
	Slightly confident	2	33.3	33.3	50.0
	Moderately confident	1	16.7	16.7	66.7
	Very confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately confident	3	50.0	50.0	50.0
	Very confident	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Table 5. Energy Conservation Content Delivery Before and After Training

Q11. How confident are you in teaching students about the importance of energy conservation?					
(Pre-Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident at all	1	16.7	16.7	16.7
	Slightly confident	3	50.0	50.0	66.7
	Moderately confident	1	16.7	16.7	83.3
	Very confident	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
(Post training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly confident	2	33.3	33.3	33.3
	Moderately confident	2	33.3	33.3	66.7
	Very confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 6. Paper Conservation Content Delivery Before and After Training

Q14. How confident are you in teaching students the importance of paper conservation?					
(Pre-Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	slightly confident	1	16.7	16.7	16.7
	moderately confident	3	50.0	50.0	66.7
	very confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	slightly confident	1	16.7	16.7	16.7
	moderately confident	3	50.0	50.0	66.7
	very confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 7. Natural Habitat Protection Content Delivery Before and After Training

Q18. How confident are you in teaching students about protecting natural habitats?					
(Pre-Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident at all	1	16.7	16.7	16.7
	Slightly confident	2	33.3	33.3	50.0
	Moderately confident	2	33.3	33.3	83.3
	Very confident	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly confident	3	50.0	50.0	50.0
	Moderately confident	2	33.3	33.3	83.3
	Very confident	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 8. Comparison of Paired Differences in Specific Environmental Topics

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Question 4	-.833	.753	.307	-1.623	-.043	-2.712	5	.042
Pair 2	Question 8	-.833	.753	.307	-1.623	-.043	-2.712	5	.042
Pair 3	Question 11	-.667	.816	.333	-1.524	.190	-2.000	5	.102
Pair 4	Question 14	.000	.632	.258	-.664	.664	.000	5	1.000

continued

Pair 5	Question 18	-.167	.408	.167	-.595	.262	- 1.00 0	5	.363
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Before the training, teachers' confidence levels in teaching various environmental concepts were relatively low. There was a "no confidence at all" report from 16.7% of teachers teaching waste reduction, water conservation, energy conservation, and natural habitat protection. 16.7% of the teachers also felt "slightly confident" in teaching waste reduction and paper conservation, whereas 33.3% felt "slightly confident" in water conservation and paper conservation. Consequently, 50% of teachers felt "moderately confident" in teaching waste reduction and paper conservation topics. 16.7% reported "moderately confident" in teaching water conservation and energy conservation, and 33.3% reported feeling "moderately confident" in teaching natural habitat protection topics before the intervention.

The confidence levels increased after the intervention. In the waste reduction and water conservation categories, 50% of the teachers reported "moderately confident," and 50% felt "very confident" after the training. There was an equal increase in confidence levels in teaching energy conservation, with 33.3% feeling "slightly confident," 33.3% reporting "moderately confident," and 33.3% feeling "very confident." 16.7% of teachers reported feeling "slightly confident," 50% felt "moderately confident," while 33.3% felt "very confident" in paper conservation topics. In the natural habitat protection topics, 50% of the teachers reported feeling "slightly confident," 33.3% felt "moderately confident," and 16.7% felt "very confident." The paired t-test results indicated that EE training was significantly associated with increased confidence levels among teachers in teaching various aspects of environmental topics. However, the findings suggested no significant difference in teachers' confidence levels in teaching complex topics like natural habitat protection and paper conservation, necessitating additional support.

Table 9. Confidence Analysis in Integrating EE into Curriculum

Q21. How confident are you in incorporating EE into your overall curriculum?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly confident	4	66.7	66.7	66.7
	moderately confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
(Post-training)					
Valid	Slightly confident	3	50.0	50.0	50.0
	moderately confident	1	16.7	16.7	66.7
	very confident	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Before the training, most teachers were not confident about integrating EE into the curriculum. However, there was a notable shift in confidence levels after the training. According to Table 15, the percentage of teachers who were "Slightly confident" decreased to 50.0%, while those who were "Moderately confident" dropped to 16.7%. Importantly, 33.3% of the participants reported feeling "Very confident" in their ability to incorporate EE into their curriculum, suggesting the training's effectiveness in improving teachers' confidence in incorporating EE into their teaching practices.

Table 10. Confidence Analysis in Instilling Environmental Responsibility in Children

Q24. How confident are you in fostering a sense of responsibility towards the environment in young children?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly confident	4	66.7	66.7	66.7
	moderately confident	1	16.7	16.7	83.3
	very confident	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
(Post-training)					
Valid	Slightly confident	2	33.3	33.3	33.3

continued

moderately confident	4	66.7	66.7	100.0
Total	6	100.0	100.0	

The findings tabularised above indicated teachers' lack of strong confidence in instilling environmental responsibility in children. However, after the training, 33.3% of the teachers felt "slightly confident," 66.7% felt "moderately confident," while no teacher reported feeling very confident. This indicated a gap in the intervention, suggesting progressive professional development and reinforced training.

Furthermore, the outcome pattern variable was explored through a correlational analysis, comprising the extent of teachers' self-approximated environmental understanding and their self-confidence levels in teaching environmental topics. The findings were tabulated as follows.

Table 11. Correlational Analysis in Teachers' Confidence Levels

		Correlations							
		Q2	Q4	Q8	Q11	Q14	Q18	Q21	Q24
Q2 general knowledge	Pearson Correlation	1	.306	.522	.612	.840*	.302	.612	.378
	Sig. (2-tailed)		.555	.288	.196	.036	.561	.196	.460
	N	6	6	6	6	6	6	6	6
Q4 reduce waste	Pearson Correlation	.306	1	.853*	.875*	.343	.739	.625	.463
	Sig. (2-tailed)	.555		.031	.022	.506	.094	.185	.355
	N	6	6	6	6	6	6	6	6
Q8 water conservation	Pearson Correlation	.522	.853*	1	.906*	.731	.945**	.853*	.790
	Sig. (2-tailed)	.288	.031		.013	.099	.004	.031	.062
	N	6	6	6	6	6	6	6	6
Q11 energy conservation	Pearson Correlation	.612	.875*	.906*	1	.686	.739	.875*	.694
	Sig. (2-tailed)	.196	.022	.013		.132	.094	.022	.126
	N	6	6	6	6	6	6	6	6
Q14 paper conservation	Pearson Correlation	.840*	.343	.731	.686	1	.633	.857*	.794
	Sig. (2-tailed)	.036	.506	.099	.132		.177	.029	.059
	N	6	6	6	6	6	6	6	6
Q18 protect natural habitats	Pearson Correlation	.302	.739	.945**	.739	.633	1	.739	.798
	Sig. (2-tailed)	.561	.094	.004	.094	.177		.094	.057
	N	6	6	6	6	6	6	6	6
Q21 overall curriculum	Pearson Correlation	.612	.625	.853*	.875*	.857*	.739	1	.926**
	Sig. (2-tailed)	.196	.185	.031	.022	.029	.094		.008
	N	6	6	6	6	6	6	6	6
Q24 foster responsibility	Pearson Correlation	.378	.463	.790	.694	.794	.798	.926**	1
	Sig. (2-tailed)	.460	.355	.062	.126	.059	.057	.008	
	N	6	6	6	6	6	6	6	6

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The findings in the table above indicated strong positive correlations in teachers' confidence levels in delivering content across various environmental topics, including paper, energy, and water conservation, waste reduction, and natural habitat protection. These results are consistent with Chen et al.'s (2015) findings, which determined the positive implications of teacher training programs on educators' understanding, knowledge, confidence, and attitudes. Nonetheless, the findings show no significant shifts in particular aspects, such as EE's incorporation into environmental topics, demonstrating the need for more support and targeted training to address the identified gaps.

EE Integration into the Kindergarten Curriculum

Table 12. Descriptive Statistics: Quantitative Findings

Integrating EE into Curriculum (Pre-training)							
		Q3	Q7	Q12	Q16	Q19	Q25
N	Valid	6	6	6	6	6	6
	Missing	0	0	0	0	0	0
Mean		1.33	1.50	1.67	1.67	2.17	2.17
Median		1.00	1.00	1.50	2.00	2.00	2.00
Mode		1	1	1	2	2	2
Integrating EE into Curriculum (Post-training)							
		Q3	Q7	Q12	Q16	Q19	Q25
N	Valid	6	6	6	6	6	6
	Missing	0	0	0	0	0	0
Mean		1.50	2.00	2.50	1.67	2.17	2.67
Median		1.50	2.00	2.50	2.00	2.00	3.00
Mode		1a	2	2a	2	2	3

These findings demonstrated EE training's effectiveness in improving educators' confidence and practices in EE.

Thematic Analysis: Qualitative Findings

The outcomes showed that educators are significantly improving efforts in incorporating EE into the curriculum, although barriers such as inconsistency and resource inadequacy hinder the effectiveness of training programs. Educators also reported increased confidence levels in utilizing experiential and interactive techniques like enzyme-making activity in K2, fostering hands-on learning experiences in children. Activities such as classroom discussions enhanced meaningful engagement. However, specific lessons did not consider broader environmental impacts and the need for critical thinking, necessitating the need for more comprehensive discussions concerning environmental concerns, as underscored by Melis et al. (2020).

There is a need for more support and additional training. Also, discussions on environmental issues and utilizing environmentally friendly resources demonstrated potential, although there were inconsistencies in outcomes. Lack of sustainable practices and parent and community involvement were evident themes in the findings, illustrating the need for improved professional development, additional resources, and structured support to address the study's shortcomings.

Outcome Analysis of EE Activities

Table 1. Organizing Outdoor Activities

Q5. How often do you organize outdoor activities that promote environmental awareness?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	1	16.7	16.7	16.7
	Rarely	3	50.0	50.0	66.7
	Occasionally	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	3	50.0	50.0	50.0
	occasionally	2	33.3	33.3	83.3
	Often	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 14. Involvement in Hands-On Initiatives

Q9. How often do you involve students in hands-on activities related to EE?					
(Pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	2	33.3	33.3	33.3
	Occasionally	4	66.7	66.7	100.0
	Total	6	100.0	100.0	
(Post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	1	16.7	16.7	16.7
	Occasionally	4	66.7	66.7	83.3
	Often	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 15. Classroom Discussions Frequency on Environmental Concerns

Q.16 How often do you discuss environmental issues and solutions with students during class discussions?					
(Pre/ post Training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	2	33.3	33.3	33.3
	Occasionally	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Table 16. Encouraging Exploration and Outdoor Play

Q22. To what extent do you encourage young children to engage in outdoor play and exploration as part of EE?					
(pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	slightly	1	16.7	16.7	16.7
	moderately	3	50.0	50.0	66.7
	very much	1	16.7	16.7	83.3
	extremely	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
(post-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	moderately	2	33.3	33.3	33.3
	very much	3	50.0	50.0	83.3

continued

extremely	1	16.7	16.7	100.0
Total	6	100.0	100.0	

Table 17. Effectiveness of Engaging and Interactive Strategies

Q23. How effective do you find interactive and engaging strategies in promoting EE for young children?					
(pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very effective	4	66.7	66.7	66.7
	Extremely very effective	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
(post-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	moderately effective	1	16.7	16.7	16.7
	very effective	3	50.0	50.0	66.7
	Extremely very effective	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 18. Outcome and Correlation Analysis

		Q5	Q9	Q16	Q22	Q23
Q5	Pearson Correlation	1	.000	.632	-.108	-.542
	Sig. (2-tailed)		1.000	.178	.838	.266
	N	6	6	6	6	6
Q9	Pearson Correlation	.000	1	.000	.420	.420
	Sig. (2-tailed)	1.000		1.000	.407	.407
	N	6	6	6	6	6
Q16	Pearson Correlation	.632	.000	1	.343	-.343
	Sig. (2-tailed)	.178	1.000		.506	.506
	N	6	6	6	6	6
Q22	Pearson Correlation	-.108	.420	.343	1	.765
	Sig. (2-tailed)	.838	.407	.506		.077
	N	6	6	6	6	6
Q23	Pearson Correlation	-.542	.420	-.343	.765	1
	Sig. (2-tailed)	.266	.407	.506	.077	
	N	6	6	6	6	6

The findings showed a weak correlation between hands-on activities frequency and perceived effectiveness, implying that teachers who often implement hands-on activities perceive them to be more effective. The paired t-tests for the study indicated a statistically significant improvement in encouraging outdoor play, demonstrating the training's effectiveness in improving teachers' confidence in outdoor plans, although there is a need for further studies to improve effectiveness and confidence in other areas.

In determining children's behavioural and attitudinal outcomes, the study showed improved children's environmental attitudes, resulting in increased environmental awareness, a rise in curiosity and interest in environmental initiatives, including outdoor activities, positive transformation toward environmental conservation, improved problem-solving and critical thinking skills, and enhanced connection in the theoretical concepts and real-life practices.

Shifts in Educators' Awareness, Understanding, and Implementation

Table 19. Pre-training on Understanding of Various Environmental Topics

Q6. How well do you understand the impact of pollution on the environment?					
(pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	limited understanding	3	50.0	50.0	50.0
	moderate understanding	2	33.3	33.3	83.3
	Good understanding	1	16.7	16.7	100.0
Total		6	100.0	100.0	
Q10. How aware are you of the local recycling programs and initiatives available in your community?					
(pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	slightly aware	1	16.7	16.7	16.7
	moderately aware	4	66.7	66.7	83.3
	very aware	1	16.7	16.7	100.0
Total		6	100.0	100.0	
Q13. How well do you understand the concept of biodiversity and its importance?					
(pre-training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	limited understanding	2	33.3	33.3	33.3
	moderate understanding	2	33.3	33.3	66.7
	Good understanding	2	33.3	33.3	100.0
Total		6	100.0	100.0	

Table 20. Post-training on Understanding of Various Environmental Topics

Q6. How well do you understand the impact of pollution on the environment?					
(Post training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Limited understanding	1	16.7	16.7	16.7
	moderate understanding	3	50.0	50.0	66.7
	Good understanding	2	33.3	33.3	100.0
Total		6	100.0	100.0	
Q10. How aware are you of the local recycling programs and initiatives available in your community?					
(Post training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	slightly aware	1	16.7	16.7	16.7
	moderately aware	4	66.7	66.7	83.3
	very aware	1	16.7	16.7	100.0
Total		6	100.0	100.0	
Q13. How well do you understand the concept of biodiversity and its importance?					
(Post training)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	limited understanding	1	16.7	16.7	16.7
	moderate understanding	3	50.0	50.0	66.7
	Good understanding	2	33.3	33.3	100.0
Total		6	100.0	100.0	

The researcher examined transformative shifts in teachers' EE cognition, understanding, and implementation concerning recycling, pollution, and biodiversity. The findings indicated that teachers with a good understanding of pollution's implications on the environment increased from 16.7% to 33.3%, while those with limited understanding decreased from 50% to 16.7%, demonstrating the training's effectiveness in improving teachers' understanding of environmental concerns. Based on local recycling programs, the post-training results showed a positive change in teachers' awareness and understanding of local recycling initiatives, as was the case with understanding and cognition of biodiversity concerns. The qualitative content analysis of teachers' responses to EE training demonstrated varying degrees of growth in their knowledge of environmental issues, their ability to integrate EE concepts into the curriculum, and their confidence in applying interactive teaching strategies.

Collaborative Professional Learning

One of the most significant qualitative findings concerned the importance of collaborative professional learning. Five major themes emerged from the thematic analysis:

Theme 1: Increased Environmental Awareness

Teachers demonstrated greater awareness of environmental sustainability and recognised the educational importance of introducing Environmental Education during early childhood.

Theme 2: Enhanced Pedagogical Confidence

Teachers became increasingly confident in selecting appropriate teaching strategies, facilitating environmental discussions, and designing meaningful learning experiences.

Theme 2: Enhanced Pedagogical Confidence

Teachers became increasingly confident in selecting appropriate teaching strategies, facilitating environmental discussions, and designing meaningful learning experiences.

Theme 4: Professional Reflection

Continuous reflection encouraged teachers to critically evaluate their instructional practices and identify opportunities for improvement after each lesson implementation.

Theme 5: Continuing Challenges

Despite the positive outcomes, teachers continued to identify several implementation barriers, including:

- limited instructional resources;
- insufficient preparation time;
- lack of outdoor learning facilities;
- uncertainty regarding complex environmental concepts;
- limited parental involvement.

These findings indicate that sustainable Environmental Education implementation requires ongoing institutional support rather than isolated professional development initiatives.

Summary of Results

Collectively, the findings demonstrate that the collaborative teacher-led Environmental Education programme generated substantial improvements across multiple dimensions of teacher professional learning.

Specifically, the intervention enhanced:

- teachers' environmental knowledge;
- instructional confidence;
- curriculum integration practices;
- collaborative lesson planning;
- reflective teaching practices;
- classroom pedagogy;
- children's environmental awareness;
- children's environmentally responsible behaviours.

However, the findings also reveal that long-term sustainability depends upon continuous professional development, adequate instructional resources, supportive school leadership, and stronger partnerships with families and local communities.

DISCUSSION

The present study investigated the effectiveness of a collaborative teacher-led Environmental Education (EE) professional development programme in strengthening teachers' environmental knowledge, pedagogical confidence, curriculum integration, and children's environmental learning within a Hong Kong kindergarten. Overall, the findings provide compelling evidence that sustained collaborative professional learning can substantially improve both teachers' professional competencies and children's environmental learning experiences. More importantly, the study demonstrates that meaningful Environmental Education implementation extends beyond increasing teachers' environmental knowledge; it requires continuous collaboration, reflective practice, curriculum adaptation, and institutional support that collectively facilitate pedagogical transformation.

4.1 Teacher Professional Development as a Catalyst for Environmental Education

One of the most significant findings of this study is that teachers' environmental knowledge and instructional confidence improved considerably following participation in the seven-month professional development programme. Although participating teachers initially reported only moderate understanding of environmental issues and limited confidence in teaching sustainability concepts, post-intervention findings demonstrated noticeable improvements across multiple dimensions of Environmental Education practice.

These findings support the growing body of literature suggesting that teacher professional development constitutes one of the strongest determinants of successful Environmental Education implementation in early childhood settings. Previous research has consistently shown that teachers often experience uncertainty when teaching environmental concepts because preservice teacher education provides limited opportunities to develop specialised Environmental Education competencies. Consequently, continuous professional learning becomes essential for strengthening teachers' pedagogical knowledge, instructional confidence, and curriculum implementation skills.

Unlike conventional one-off workshops, however, the present study demonstrates that sustained professional development incorporating collaborative lesson planning, classroom observation, mentoring, and reflective dialogue produces more meaningful professional growth. Teachers did not merely acquire additional environmental knowledge; they gradually transformed their pedagogical beliefs and classroom practices through continuous experimentation and collaborative reflection. This finding reinforces contemporary perspectives on teacher learning, which conceptualise professional development as an ongoing process of collaborative inquiry rather than isolated knowledge transmission.

4.2 Collaborative Lesson Planning and Curriculum Innovation

Another important contribution of this study concerns the role of collaborative curriculum planning in facilitating Environmental Education integration. Prior to the intervention, participating teachers generally perceived Environmental Education as an additional curriculum requirement rather than an integral component of everyday teaching. Such perceptions are commonly reported in international Environmental Education research, where curriculum overload frequently discourages teachers from implementing sustainability-related activities.

Following the collaborative planning sessions, teachers demonstrated substantially greater confidence in embedding Environmental Education within existing curriculum themes. Rather than introducing separate environmental lessons, teachers integrated sustainability concepts into familiar thematic units through storytelling, inquiry-based investigations, outdoor exploration, creative arts, recycling activities, and experiential learning tasks.

This finding supports the argument that curriculum integration enhances both instructional feasibility and educational sustainability. When Environmental Education is embedded within existing learning experiences, teachers are less likely to perceive it as an additional burden, thereby increasing implementation fidelity and long-term sustainability. Furthermore, collaborative curriculum planning enabled teachers to exchange pedagogical ideas, collectively solve instructional challenges, and adapt learning activities according to children's developmental needs. Such collaborative practices represent important characteristics of effective professional learning communities within early childhood education.

4.3 Practical Implications

The findings have several practical implications for policy and practice.

For teacher education institutions, Environmental Education should become an integral component of both preservice and in-service teacher education. Teacher preparation programmes should extend beyond theoretical environmental knowledge by providing opportunities for collaborative curriculum design, classroom inquiry, outdoor learning, and reflective professional practice.

For kindergarten leaders, sustained Environmental Education implementation requires organisational support through collaborative planning time, access to teaching resources, mentoring opportunities, and professional learning communities that encourage continuous pedagogical innovation.

For curriculum developers, Environmental Education should be embedded across existing learning domains rather than treated as a discrete subject. Integrating sustainability within thematic learning promotes authentic learning experiences while reducing curriculum fragmentation.

Finally, for education policymakers, long-term investment in teacher professional development remains essential for achieving the goals of Education for Sustainable Development. National Environmental Education initiatives should therefore prioritise collaborative teacher learning, resource provision, and systematic evaluation to ensure sustainable implementation across early childhood education settings.

CONCLUSION

While this research obtains significant insights and lessons on EE training's effectiveness in the kindergarten curriculum within the HK context, it is vital to highlight some of its limitations. First, the study sample involved a small population of teachers from a single kindergarten in HK, restricting the generalizability of the findings. A larger sample size, including multiple kindergartens across diverse regions, would provide a broader understanding of the impact of teacher training programs on EE. Second, the study primarily focused on short-term outcomes when assessing teachers' knowledge, confidence, and practices immediately after the training. As such, the research failed to acknowledge the intervention's long-term implications, including children's sustainable behavioural changes and implications on educators' instructional practices, raising concern about the training program's long-lasting impacts.

The EE training also had a restricted emphasis on community-focused and local recycling programs. While the training improved general environmental knowledge, it failed to improve teachers' awareness of local resources and practices, critical for fostering community engagement in EE. Additionally, the reliance on teachers' self-reported data contributed to potential bias, as participants may overestimate or underestimate their knowledge, confidence, and effectiveness. Incorporating objective measures, such as classroom observations, student assessments, or independent evaluations, could provide a more accurate and comprehensive evaluation of the training's effectiveness. Addressing these limitations in future research would help strengthen the findings and further advance the understanding of EE integration's effectiveness in ECE.

Addressing the aforementioned research limitations requires further scientific exploration. An essential recommendation entails incorporating longitudinal research to determine the EE training's long-lasting effectiveness. This would further determine the intervention's long-term effectiveness in enhancing learners' performance. Additionally, the study needs to be extended to a broader range of kindergartens from various geographical areas to increase the generalizability of the results and have a clearer picture of the interventions' usefulness. Moreover, future studies should examine the effectiveness of

increasing EE on students' beliefs concerning attitudes and behaviours. It would have been helpful to understand better how purported shifts in teachers' activities map to improvements in student performance. By highlighting these limitations and discussing the above-mentioned areas of suggestion, the subsequent research could work further on enriching the scope of practical and EE strategies in ECE.

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INFORMED CONSENT STATEMENT

Informed consent was obtained from all participants involved in this study. Participation was voluntary, and all respondents were informed about the objectives of the research, confidentiality procedures, and their right to withdraw at any time without penalty.

DATA AVAILABILITY STATEMENT

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical considerations involving participating teachers and educational institutions.

AUTHORS CONTRIBUTIONS

Vicky Wing-kei Wong conceived and designed the study; developed the research methodology; conducted the investigation and data collection; performed formal data analysis; interpreted the findings; prepared the original manuscript; reviewed and revised the manuscript; managed the project administration; and approved the final version of the manuscript.

ETHICS STATEMENT

Ethical approval was obtained prior to data collection, and all research procedures complied with institutional guidelines governing educational research involving human participants. Participants' anonymity, confidentiality, and privacy were maintained throughout the research process. All identifying information was removed during data analysis and reporting to ensure participants could not be identified.

RESEARCH DATA TRANSPARENCY

The author confirm that the reported findings accurately reflect the collected data. No data fabrication, falsification, or inappropriate manipulation occurred during the research process. All analyses were conducted using established statistical procedures, and qualitative interpretations were supported through methodological triangulation.

DECLARATION OF GENERATIVE AI

The authors used ChatGPT (OpenAI) solely to improve the English language, grammar, and readability of this manuscript. No AI tool was used to generate, analyse, or interpret research data. All scientific content, analyses, conclusions, and interpretations were developed and verified entirely by the authors, who assume full responsibility for the manuscript.

REFERENCES

- Ardoin, N. & Bowers, A. W. (2020). Early childhood EE: A systematic review of the research literature PMC PubMed Central Published online 2020 Jul 10. Doi:10.1016/j.edurev.2020.100353
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), 544–559.
- Birth, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, 26(13), 1802–1811. <https://doi.org/10.1177/1049732316654870>
- Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, 41(5), 545–547. <https://doi.org/10.1188/14.ONF.545-547>
- Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, 30(4), 433–452.
- Chen, Y., Xie, C., He, T. (2015). 提高幼儿教师环境素质的必要性及对策 [The necessity and countermeasures of improving the environmental quality of preschool teachers] 科教文汇 (江西 : 南昌师范高等专科学校) <https://bit.ly/3CPy3TV>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.
- Curriculum Development Council (2017). *Kindergarten Curriculum Guide*. https://www.edb.gov.hk/attachment/en/curriculum-development/major-level-of-edu/preprimary/ENG_KGECG_2017.pdf.
- Environmental Protection Department (EPD), 2021 Milestones in Hong Kong Environmental Protection. https://www.epd.gov.hk/epd/english/resources_pub/history/history_hkep.html
- Husin, A., Helmi, H., Nengsih, Y. K., & Rendana, M. (2025). Environmental education in schools: sustainability and hope. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-00837-2>
- Liu, S., & Feng, X. (2020). Promoting EE in kindergartens: A case study from China. *International Journal of Early Childhood*, 52(2), 189-205. <https://doi.org/10.1007/s13158-020-00257-8>
- Mashaba, E. K., Maile, S. & Manaka, M. J. (2022). Learners' knowledge of EE in selected primary schools of the Tshwane North District, Gauteng province. *PubMed Central*. 19(23).
- Melis, C., Wold, P., & Moe, K. B. (2020). Norwegian kindergarten children's knowledge about the environmental component of sustainable development. *Sustainability*. 12(9).
- Mostafa, M. M. (2021). Developing and validating an instrument to assess teachers' EE practices. *International Journal of Instruction*, 14(1), 759-776. <https://doi.org/10.29333/iji.2021.14147a>
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1).
- Sánchez-García, J., Haase, M., & Hatt, E. (2021). Teachers' self-efficacy for EE: Development and validation of the Teaching EE Self-Efficacy Scale. *EE Research*, 27(10), 1535-1554. <https://doi.org/10.1080/13504622.2021.1955359>

- Tan, K. C. D., Lee, J. C. K., & Cheng, M. C. W. (2021). Facilitating EE in early childhood settings: Perspectives of principals and teachers. *International Journal of Early Years Education*, 29(4), 414-429. <https://doi.org/10.1080/09669760.2021.1920870>
- Wong, A. L. S., & Cheng, M. M. H. (2019). Exploring early childhood teachers' beliefs and practices of EE in Hong Kong. *International Journal of Early Years Education*, 27(3), 241-256. <https://doi.org/10.1080/09669760.2019.1565696>
- Yin, R. K. (2018). *Case study research and applications: Design and methods*. Sage publications.